CIRCUIT INTERRUPTION TECHNIQUES

Advantages of Federal Pacific Circuit Interruption Technique

The Federal Pacific Auto-jet® Switch is unsurpassed in the industry for its switching capability as an air-insulated load interrupter. It passes the ANSI standards C37.20.3, C37.57, C37.58 and all the optional and preferred ratings in IEEE C37.74. UL® listed at 5kV and 15 kV and used extensively in MSHA approved equipment. Interrupter switches available today utilize one of four (4) interrupting/insulating medium technologies: (1) gas (SF6), (2) liquid (oil), (3) vacuum, and (4) air.

Gas (SF6)

It is an excellent interrupting/insulating medium. However, it is risky since it is on the UN (Kyoto Treaty) list of contaminants as the worst greenhouse gas. It is also very expensive and production capabilities have been reduced, increasing the cost. It is difficult to recapture if it is leaking and tank evacuation for repair requires special handling to avoid contamination and an equally costly storage housing. Arcing in SF6 creates carcinogenic materials, which must be handled and disposed of in a secure manner. Pressure gauges and gas-fill ports are required.

Liquid (Oil)

It is also a good interrupting/insulating medium, but not as good as SF6. It can be vulnerable to ignition when used as the interrupting medium. Even the biodegradeable types are not perfectly absorbed. In addition, the containers may leak and make for messy, costly handling, clean up and disposal. Testing is necessary to verify the integrity of the liquid dielectric.

Vacuum

Vacuum is also an excellent interrupting/insulating medium, but involves a sophisticated technology. However, vacuum bottles are also expensive. You cannot see the interrupting contacts so there is no visible disconnect, which is a security requirement for many users. The vacuum contacts also wear and will need to be serviced. Vacuum circuit breakers may require control power for operation such as a battery, which is another maintenance headache.

Again, these three technologies are approximately 20% more expensive than our technology, which originated in Europe. In addition, we have added many more improvements to survive in the rugged North and South American and Caribbean markets. Our technology also has none of the risks associated with SF6, oil, and vacuum.

Air

We use this technology. It is plentiful, easy to control, and has no negative by-products. For this technology, there are two types of circuit-interrupting techniques, namely, ablative and puffer. You are all familiar with the ablative type that uses knife blades that are less robust and therefore not as durable, so they may require maintenance.

For example, the ablative switch depends on eroding (consuming) the arc chute or arc compressor (that surround the blade) to generate the gases required to cool and extinguish the arc. That means the arc chute is producing a build-up of carbon inside each time it operates. At some point, it will not be able to generate the necessary gas, which typically will occur in only 10-20 operations.

The Federal Pacific Auto-jet® load-interrupter switch employs a unique, reliable method of circuit interruption. The switch is available in ratings to 1200 amperes continuous and interrupting and is designed to provide three-time duty-cycle fault-closing and momentary ratings to 40,000 amperes asymmetrical. A one-time duty-cycle fault-closing rating of 61,000 amperes asymmetrical is also available. By employing a simple puffer mechanism combined with air as a renewable arc-interrupting medium, the Auto-jet® switch is unsurpassed in the industry with its complete range of switching capabilities. The switch is capable of 100 full-load circuit interruptions at 600 amperes without maintenance.

The performance of the switch is insured by its rugged, heavy-duty quick-make, quick-break stored-energy mechanism, which provides high-speed opening and closing independent of the speed of the switch-operating handle. Spring loaded interrupting contacts add increased speed of separation at the point of arc formation to reduce contact wear and to increase the dielectric gap at the instant contacts separate.

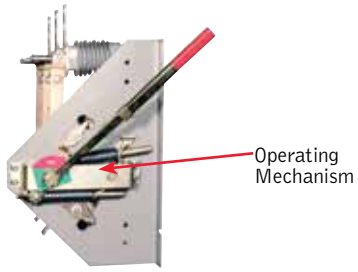
The heavy-duty construction of the switch blades, contacts, insulators and support frame provides the ruggedness necessary to withstand — through multiple operations — the electrical, mechanical and magnetic forces generated during all types of switching operations. This capability makes the Auto-jet® switch the ideal choice for manual, remote-controlled, and automatic switching in pad-mounted and metal-enclosed switchgear.

Comparison — Puffer Technology vs. Ablative Technology

- The puffer interrupter is capable of 100 full-load circuit interruptions at 600 amperes without maintenance compared to the only 10-20 operations for ablative switches.
- The puffer interrupter is rated at three (3) time duty-cycle fault-closing at 40,000 amperes without maintenance compared to just one or two-time fault closing at only 22,400 amperes for some ablative switches. Some puffer interrupters have even performed through four fault-closings, which the ablative switches have not. In addition, the puffer interrupter has been tested to 1200 amperes continuous and interrupting with a one-time duty-cycle fault-closing rating of 61,000 amperes asymmetrical.
- The puffer interrupter has a capability beyond 1000 mechanical operations without requiring service.

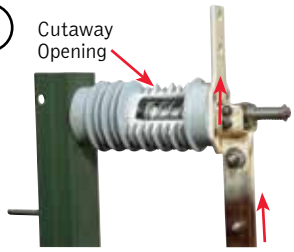
The operating sequence of the Federal Pacific Auto-jet® Load-Interrupter Switch is depicted in the accompanying photographic series.

1



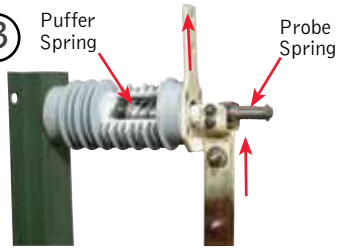
Switch closed. Normal current path through lower switch terminal, through switch blades to main-contact and out top terminal pad.

2



Quick-make quick-break mechanism on switch is charged using manual handle and discharges to open switch.

3

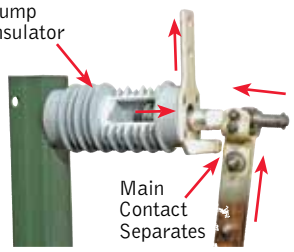


As switch blade starts to move, interrupting contacts (probe contact and tulip contact remain engaged) and puffer assembly starts to move. As puffer assembly starts to move, the spring surrounding the puffer assembly begins to compress, as does the spring at the back of the probe.

4

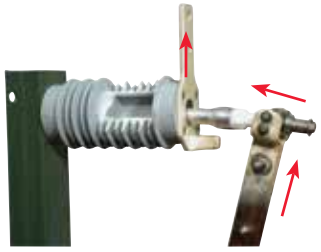
Switch opening. As switch blade continues to move, the probe and puffer springs are further compressed and the initial electrical change occurs as the switch blade starts to separate from the main-contact.

5



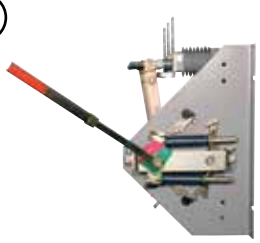
Air is being pulled into the chamber of the pump insulator. As the switch blade and main contact separate, current is now diverted through the probe contact, to the tulip contact, through the puffer housing, to the puffer spring, to the back of the main contact, and out the top of the terminal pad. Three and one-half cycles have elapsed.

6



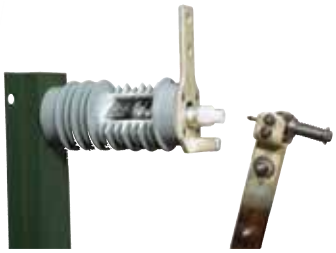
The puffer spring and the probe spring continue to compress as the blade moves further away from the main contact. The springs are nearly fully compressed and air continues to be pulled into the chamber of the pump insulator. As the springs become fully compressed, the probe and the tulip contacts will start to separate.

7



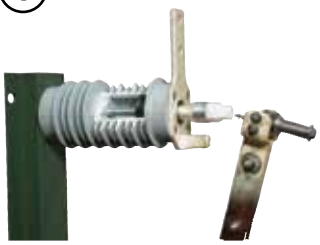
Interrupter contacts separate. As the springs are fully compressed, the probe and the tulip contacts will start to separate. The charged puffer spring now quickly pulls the puffer assembly, which includes the tulip contact, back into the pump-insulator chamber.

8



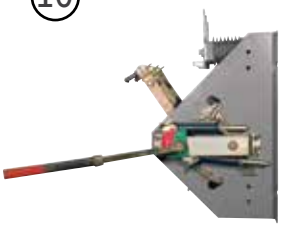
Air in the chamber is forced through the central core of the puffer into the arcing area at the tip of the tulip contact. Simultaneously, the probe spring pulls back the probe. Complete switch operation occurs in a total 5-cycle operating time.

9



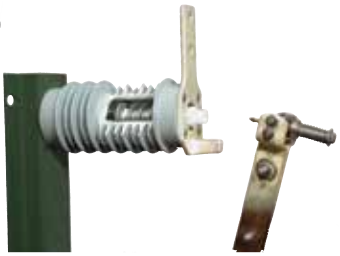
At the time of contact separation, not only is the discharging operating mechanism pushing the blade very fast, but the probe and puffer springs are applying energy to rapidly separate the interrupting contacts, which are only in the circuit for 1.5 cycles of the total operating time.

10



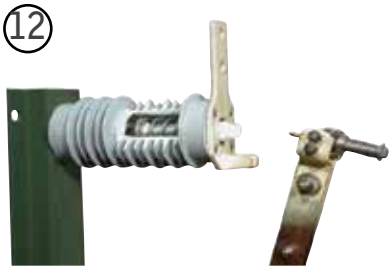
Switch Open. The switch blade has moved to the fully open position.

11



The process from the instant the switch blade starts to move until circuit interruption is achieved takes only 5 cycles.

12



The arc is extinguished and there is a full dielectric air gap between the switch blade and the main contact.

AUTO-JET® & AUTO-JET® II SWITCHES 5-35kV

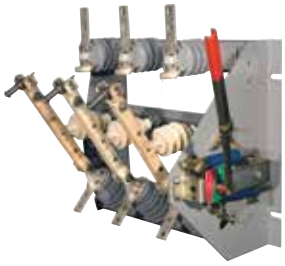
Federal Pacific has designed and manufactured a family of laboratory tested and field proven air-insulated, load-break switches since 1978. The original Auto-jet® switch and later the Auto-jet® II switch provide the same unique method of load interruption, producing a laminated jet of air which extinguishes the arc.

Both switches are designed to provide a safe, convenient means of three-pole switching of distribution transformers, cable loops and laterals, and provide automatic or manual switching of preferred and alternate sources.

The Auto-jet® II was introduced to accommodate smaller sized live-front and dead-front pad-mounted switchgear. The larger sized Auto-jet® is used in specialty applications and at 38 kV. Both provide 600 amperes continuous and load-break at rated voltage, 40,000 amperes RMS/ASYM momentary and three-time fault-close capability. Switches rated to 1200 amperes continuous and load-break with a 61,000 ampere one-time duty-cycle fault-closing rating are available.

All switches have a heavy-gauge steel frame, which assures proper contact alignment and eliminates any problem of switch-to-enclosure alignment. An optional all stainless-steel switch is available (current-carrying parts are not stainless-steel). A quick-make, quick-break stored-energy mechanism with heavy-duty, long-life die springs provides high-speed opening and closing independent of the operating handle speed. This high-speed mechanism assures the duty-cycle fault-closing capability and load interruption with the patented Federal Pacific interrupter. The switch blades are made of high conductivity copper. Current transfer from the switch blade through the hinge to the load terminals is accomplished by a unique current transfer means, consisting of a beryllium-copper louvered contact band encircling a copper pin at the hinge point. Magnetic forces, due to a higher than normal current flow, tend to rotate the louvers on the contact band toward a vertical position, providing a higher contact pressure for fault-current duty.

Electrical integrity is enhanced by 100% x-rayed cycloaliphatic epoxy insulators. Typical applications include metal-enclosed switchgear, pad-mounted switchgear, metal-enclosed wall-mounted switch cabinets and transformer primary compartments. The switches are available with either left or right hand operator and either direct hex shaft side operation or front chain-drive operation.



AUTO-JET® II
15kV, 600 AMPERE

AUTO-JET® II
15kV, 1200 AMPERE

AUTO-JET® 34.5kV,
600 AMPERE

AUTO-JET® RATINGS

Catalog Number	Mounting Arrangements †	kV			Amperes, RMS					Fault-Close Duty-Cycle	Net Weight (Lbs.)
		Nom.	Max. Des.	BIL	Max. Cont.	Interrupting			Mom. & Fault-Close (ASYM KA)		
						Max. Load	Cable	Mag.			
0008-4-53151M ① ⑤	N,H	34.5	38	150	600	600	20	21	40*	3*	178
0035-4-53152 ① ⑤	N,H	34.5	38	150	600	600	20	21	40*	3*	178
0036-4-53153 ① ⑤	N,H	34.5	38	150	600	600	20	21	40*	3*	178

AUTO-JET® II RATINGS

Catalog Number	Mounting Arrangements ⑥	kV			Amperes, RMS					Fault-Close Duty-Cycle	Net Weight (Lbs.)
		Nom.	Max. Des.	BIL	Max. Cont.	Interrupting			Mom. & Fault-Close (ASYM KA)		
						Max. Load	Cable	Mag.			
0037-4-53168M ① ⑤	N,H	14.4	17	95**	600	600	10	21	40*	3*	110
0037-4-53169M ④ ⑤	N,H	14.4	17	95**	600	600	10	21	40*	3*	110
0037-4-53152 ② ⑤	N,H	14.4	17	95**	600	600	10	21	40*	3*	110
0037-4-53151 ③ ⑤	N,H	14.4	17	95**	600	600	10	21	40*	3*	110
34-5121-02 †	N,H	14.4	15.5	95**	1200	1200	10	21	60†	1T	110
0038-4-53152M ① ⑤	N,H	25	27	125**	600	600	15	21	40*	3*	130
0039-4-53152M ④ ⑤	N,H	25	27	125**	600	600	15	21	40*	3*	130
0038-4-53152 ② ⑤	N,H	25	29	125**	600	600	15	21	40*	3*	130
0039-4-53152 ③ ⑤	N,H	25	29	125**	600	600	15	21	40*	3*	130
34-5135-01 ② ⑤	N,H	25	27	125**	900	1200	15	21	40*	3*	130
34-5136-01 ③ ⑤	N,H	25	27	125**	900	1200	15	21	40*	3*	130

① For front operation with handle on right.
② For side operation (3/4"hex operating shaft) handle on right.
③ For side operation (3/4" hex operating shaft) handle on left.
④ For front operation handle on left.
⑤ Handles and barriers not included.

⑥ Mounting arrangements:

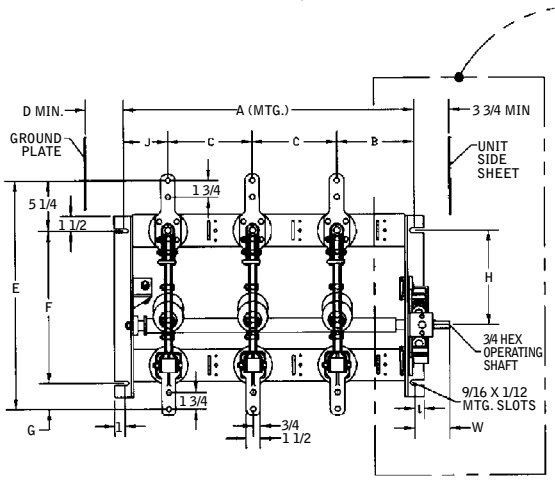
(N) Normal

(H) Horizontal

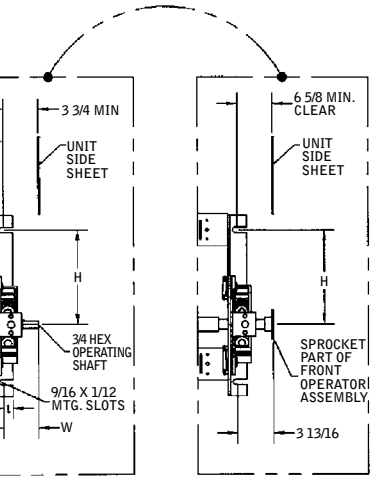
* The three time duty-cycle fault-closing rating means that the switch can be closed three times into rated fault amperes and remain operable and able to carry and interrupt its rated load current.
† This switch has a one-time duty-cycle fault-closing rating of 61,000 ampere asymmetrical and a three-time duty-cycle fault-closing rating of 40,000 amperes asymmetrical, following which it will remain operable and able to carry and interrupt load current.
** Barriers installed.

Three-Phase Auto-jet® Switches

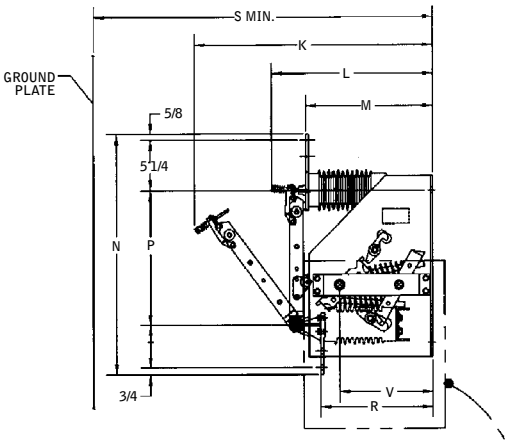
Dimensions not to be used for construction purposes.
Refer to the factory for detailed construction drawings.

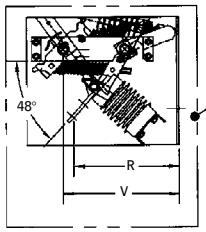


Front View
(Right Hand Operation Shown)



Side Operated **Front Operated**





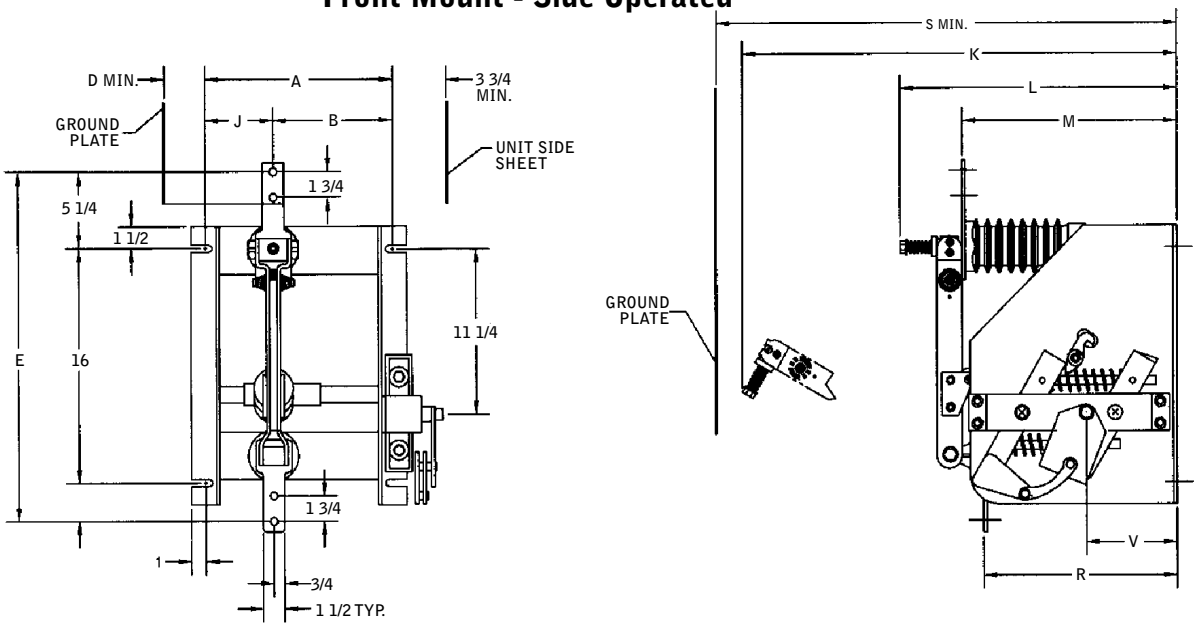
15kV AJII Switch Only

AUTO-JET® SWITCH																				
kV Class	Amps Cont. & Load-Break	Catalog Number	DIMENSIONS - INCHES																	
			A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	V	W
35	600	0008-4-53151M	44	12-1/4	13	5-1/2	27-1/2	16	4-7/8	4-3/8	5-3/4	37-1/2	22-5/8	18-13/16	29	16-5/8	17-1/16	48	4-1/2	6-1/4	4-5/8
		0035-4-53152	44	12-1/4	13	5-1/2	27-1/2	16	4-7/8	4-3/8	5-3/4	37-1/2	22-5/8	18-13/16	29	16-5/8	17-1/16	48	4-1/2	6-1/4	5-3/8
		0036-4-53153	44	12-1/4	13	5-1/2	27-1/2	16	4-7/8	4-3/8	5-3/4	37-1/2	22-5/8	18-13/16	29	16-5/8	17-1/16	48	4-1/2	6-1/4	5-3/8
AUTO-JET® II SWITCH																				
kV Class	Amps Cont. & Load-Break	Catalog Number	DIMENSIONS - INCHES																	
			A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	T	V	W
15	600	0037-4-53168M	26-5/8	7	7-11/16	3-1/4	24-7/16	16	3/4	9-3/4	4-1/4	21	12-5/8	9-5/16	25-13/16	14-1/8	11-1/16	27	2-3/4	12-1/4	3-19/32
		0037-4-53169M	26-5/8	7	7-11/16	3-1/4	24-7/16	16	3/4	9-3/4	4-1/4	21	12-5/8	9-5/16	25-13/16	14-1/8	11-1/16	27	2-3/4	12-1/4	3-19/32
		0037-4-53152	26-5/8	7	7-11/16	3-1/4	24-7/16	16	3/4	9-3/4	4-1/4	21	12-5/8	9-5/16	25-13/16	14-1/8	11-1/16	27	2-3/4	12-1/4	3-19/32
		0037-4-53151	26-5/8	7	7-11/16	3-1/4	24-7/16	16	3/4	9-3/4	4-1/4	21	12-5/8	9-5/16	25-13/16	14-1/8	11-1/16	27	2-3/4	12-1/4	3-19/32
25	600	0038-4-53152M	31	8-1/4	9	4	23-7/8	16	2-5/8	9-15/16	4-3/4	28	17-3/8	13-7/16	25-1/4	14-1/8	11-11/16	36	4-1/2	9-7/8	3-11/16
		0039-4-53152M	31	8-1/4	9	4	23-7/8	16	2-5/8	9-15/16	4-3/4	28	17-3/8	13-7/16	25-1/4	14-1/8	11-11/16	36	4-1/2	9-7/8	3-11/16
		0038-4-53152	31	8-1/4	9	4	23-7/8	16	2-5/8	9-15/16	4-3/4	28	17-3/8	13-7/16	25-1/4	14-1/8	11-11/16	36	4-1/2	9-7/8	3-11/16
		0039-4-53152	31	8-1/4	9	4	23-7/8	16	2-5/8	9-15/16	4-3/4	28	17-3/8	13-7/16	25-1/4	14-1/8	11-11/16	36	4-1/2	9-7/8	3-11/16

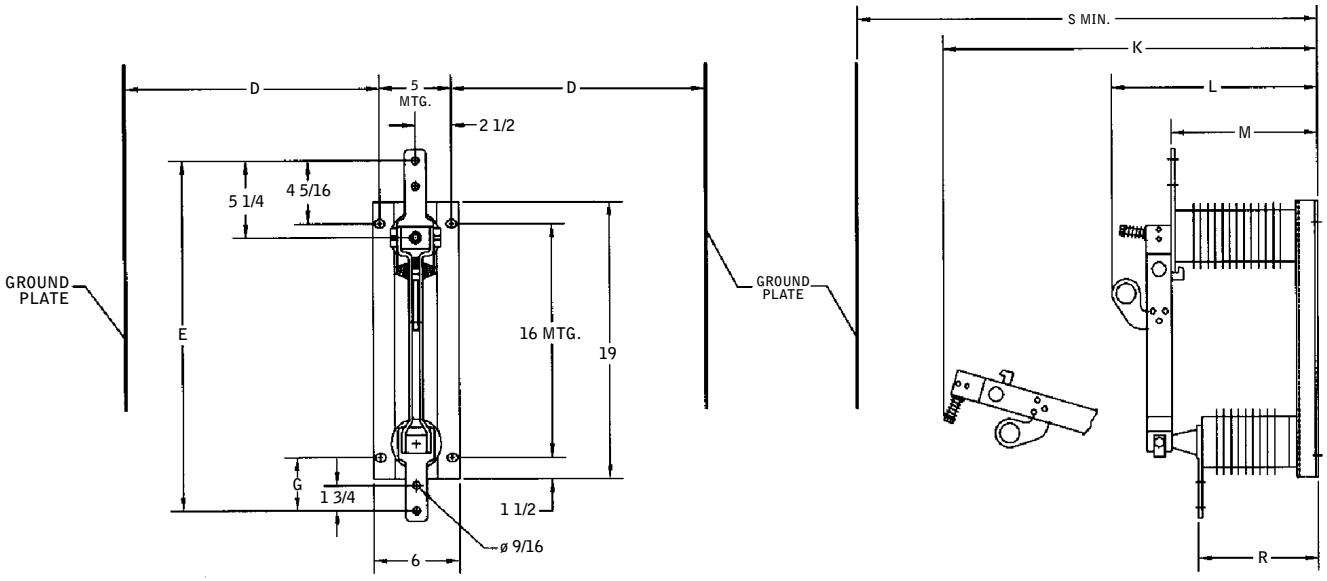
Single-Phase Auto-jet® Switches

Dimensions not to be used for construction purposes.
Refer to the factory for detailed construction drawings.

Front Mount - Side Operated



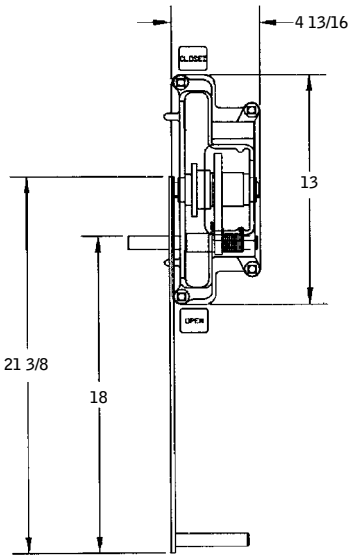
Channel Mounted - Hookstick Operated

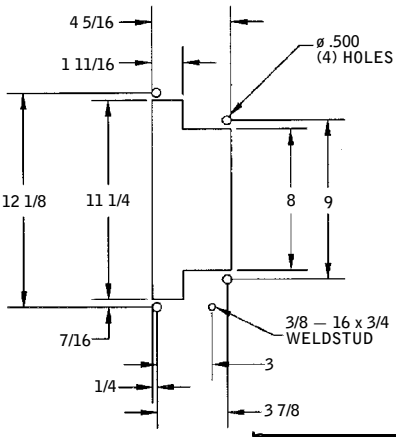


Type	kV Class	kV BIL	Catalog Number	Dimensions - Inches												
				A	B	D	E	G	J	K	L	M	R	S	V
Hookstick	15	95	0006-4-53151	N/A	N/A	5-1/4	23-7/8	3-9/16	N/A	26	14-3/4	10-1/16	7-15/16	32	N/A
	25	125	0007-4-53151	N/A	N/A	6-3/4	23-7/8	3-9/16	N/A	27	15-5/16	11-1/8	9-1/4	35	N/A
Side Operated	15	95	0013-4-53153 ①	13	8-1/4	2-13/16	23-7/8	2-5/8	4-3/4	29	17-3/4	13-7/16	11-7/8	35	6-1/4
	25	125	See Factory	15	10-1/4	5-1/2	23-7/8	2-5/8	4-3/4	30-1/2	19-1/4	14-15/16	13-7/16	38-1/2	6-1/4

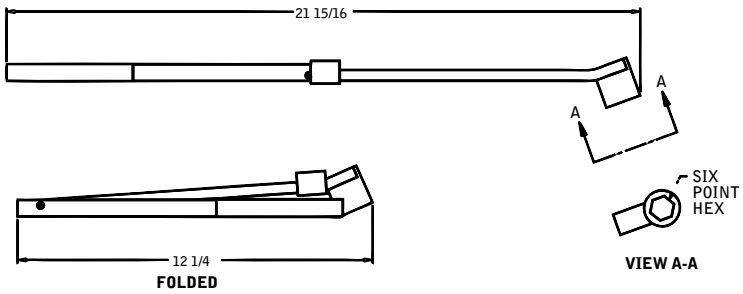
① For side operation with handle on right.

Side and Front Operators



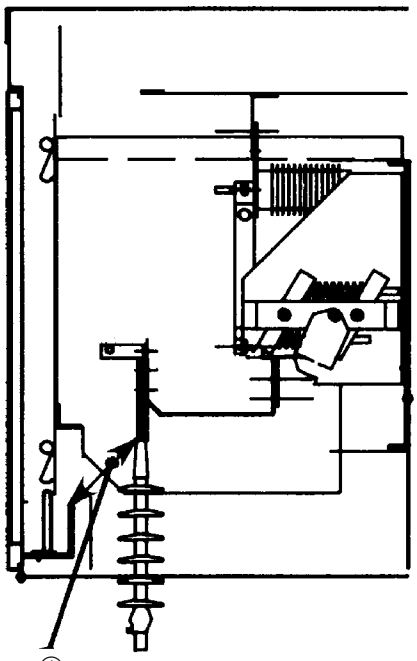


HANDLES	
Type	**Catalog Number**
Side Operation	0018-2-02870
Front Operation For Use Without Key	33-6029-01
Front Operation For Use With Key	33-6029-04

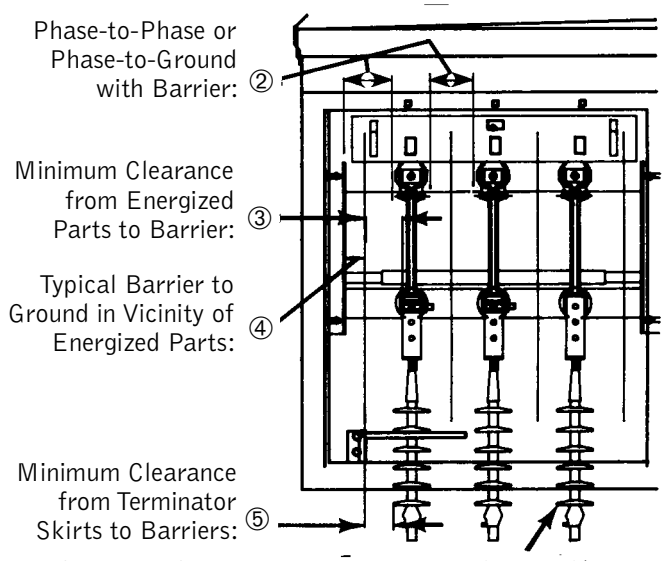


15kV, 25kV, 35kV Pad-Mounted Unit Rating kV, BIL	Recommended Minimum Clearances In Inches				
	Phase-to-Phase or Phase-to-Ground Without Barrier ①	Phase-to-Phase or Phase-to-Ground With Barrier ②	Energized Bus (or device) to Barrier ③	Barrier to Ground in Vicinity of Energized Bus (or device) ④	Terminator Skirts to Barriers ⑤
95	5-1/2	3"	1-1/4"	1"	1/2"
125	7-1/2	5"	2"	1-1/4"	1-1/4"
150	10	7-1/2"	3"	2"	2"

NOTES:



① Minimum clearance from energized parts to electrical ground without barrier.



G. E. Type G Termi-matic Termination System Shown

TYPE PM MOTOR OPERATORS FOR AUTOMATIC SOURCE-TRANSFER AND SCADA CONTROLLED APPLICATIONS 15kV • 25kV

Run-and-Trip Style and Fast-Trip Style

Federal Pacific Type PM Switch Operators are available in two styles (Run-and-Trip Style and optional Fast-Trip Style) depending on the speed of operation required for the specific application. Regardless of the speed of operation, these motor operators are side mounted to units of 15kV and 25kV live-front or (as illustrated above) dead-front pad-mounted switchgear and provide motor-operated switching for automatic-transfer and remote supervisory-controlled applications on underground power distribution systems. Automatic-transfer unit pictured above illustrates motor-operator mounting in low-voltage compartments at left and foreground enclosure on side at right. Low-voltage enclosure at far right contains micro-processor control and associated wiring.

Federal Pacific Motor Operators to Automate Underground Distribution Systems

Federal Pacific 15kV and 25kV Manual Models of Pad-Mounted Switchgear can be equipped with motor operators either for automatic source-transfer applications, designated as ATPSI/II Models for Live-Front units and ATPSE Models for Dead-Front units, or for SCADA controlled applications, designated as SCPSI/II Models for Live-Front units and SCPSE Models for Dead-Front units. When equipped with motor operators, Federal Pacific Models of Pad-Mounted Switchgear will effect switching operations in a run (charge-spring) and trip sequence in approximately 6-8 seconds or alternately, with an optional Fast-Trip design in approximately 15 cycles. These operating times do not include time delays required for coordination or verification that the event is not permanent.

Run-and-Trip Motor Operator

The Federal Pacific Type PM Motor Operator, dubbed the run-and-trip motor operator includes all the features that have been provided in the past for motor operators used in remote-supervisory control applications.

The operating speed for the Run-and-Trip Style Type PM Motor Operator is approximately 4-5 seconds from the instant the motor is actuated through to completion of switch opening or closing. Operation can be effected either automatically when combined with an SEL-451 Relay or remotely when combined with appropriate communications components. Operating time for the automatic source-transfer scheme using the Run-and-Trip Style Type PM Motor Operator is approximately eight (8) seconds. Operating time does not include time required for sensing or time delays required to establish system conditions. These motor operators can also be used in selected configurations of Federal Pacific Metal-Enclosed switchgear.

Fast-Trip Style Type PM Motor Operators

The operating speed for the Fast-Trip Style Type PM Motor Operator is approximately 6-8 cycles from the instant the motor is actuated through to the completion of switch opening or closing. Operation can be effected either automatically when combined with an SEL-451 Relay or remotely when combined with appropriate communications components. Operating time for the automatic source-transfer scheme using the Fast-Trip Type PM Motor Operator is approximately 15 cycles. Operating time does not include time required for sensing or time delays required to establish system conditions. These motor operators can also be used in selected configurations of Federal Pacific Metal-Enclosed switchgear.

Type PM Motor Operators

Whether Run-and-Trip Style or Fast-Trip Style, the Federal Pacific Type PM Switch Operator is designed primarily for use on Federal Pacific units of pad-mounted switchgear, replacing the manual operating handle and placed over the manual-operating shaft. However, it may also be applied for specific unique applications when side mounted to bays of metal-enclosed switchgear. The run-and-trip motor operator is direct, side-connected to the enclosure of pad-mounted switchgear, and can be similarly connected on bays of metal-enclosed switchgear where space and configuration arrangements permit. A direct, front-connected arrangement is also available for metal-enclosed switchgear (refer to the Federal Pacific Switchgear Product Catalog section on "Automatic Metal-Enclosed Switchgear" and Figure 2 on page 135).

The Type PM motor-operator enclosure is an aluminum NEMA 3R, which is rated for outdoor service. The door opening is fully gasketed and seals tight against the door to prevent entry of rain and contamination. The door includes a stainless-steel handle, a continuous, stainless-steel hinge, a storage pocket for the instruction manual, a mounting clip for storage of spare secondary control-circuit fuses, a manual operating handle with storage provisions, and a wind brace to hold the door open.

Remote-Supervisory Control Applications

The Type PM motor operator includes LOCAL/REMOTE selector switch, local controls, control and battery charger/manager electronic components, AC power and control cable connections, provision for other optional controls, and provision for an RTU and radio/phone. The electronically controlled motor unit is suitable for operation of both 15kV and 25kV 600-ampere and 1200-ampere Federal Pacific Auto-jet® Load-Interrupter Switches.

The motor unit also includes a decoupler that when decoupled from the switch allows exercising the motor without operating the disconnect switch. The decoupler thus allows functional operation of the motor to be performed as a part of normal maintenance and checkout procedure. The Type PM Motor Operator uses a solid-state controller, which provides consistent and accurate control at each end of the interrupter switch operating stroke. It has a user programmed electronic control that responds to an electronic sensor enclosed within the motor housing. Limit positions are set from the control panel. The controller also provides open and closed position status outputs for an RTU.

Figure 1. Federal Pacific Type PM motor operator enclosures include many features providing convenience and security.

The operating controls, mounted on a panel inside the enclosure, consist of the Local-Remote Selector Switch, the Close-Open Switch and two Indicator Lights to show switch position. Three push buttons, mounted below the control switches behind a secured protective cover; set and adjust the motor-limit controls. Programming controls have safety covers to prevent accidental contact with the limit control during normal local operations.

When a CLOSE or OPEN command is given from either the "Remote" or "Local" position, the command is "sealed in"; and the motor will run to its established limits of travel and cannot be stopped at an intermediate position. The Type PM unit, in most situations, uses 120 volts AC in tandem with DC power supplied by the battery backup system to operate the load-interrupter switch. An electronic battery charger and battery manager system maintains battery voltage and provides battery condition status output signals for an RTU.

Modular construction and plug-in connections make maintenance and service easy.

The unit weighs approximately 100 Lb. (45 Kg) without the packing.

For the motor operator in remote-supervisory control applications, a 12-volt, 33-amp-hour battery supplies power to the motor-operator assembly and has adequate capacity to power associated components, including an optional radio and RTU. A 24-volt DC battery and charging system is also available. A system combining a battery and 120-volt AC input to a battery charger permits motor operation even when there is a weak battery voltage.

The battery charger is temperature compensated. With loss of input power from the charger, the battery can typically maintain the RTU and radio loads for 24 hours. The system includes an electronics package that provides (1) battery overcharge protection and (2) battery testing. Status outputs wired for input to an RTU include: Switch Position, Battery Condition, and Monitoring of Controller Status.

Sufficient open space provided on the internal mounting plate for installation of communications components, both a remote-terminal unit (RTU) and radio or other communications portal, for remote-supervisory control operations. When ordering, if specified, an antenna can be installed or provisions provided on the enclosure.

Figure 2. Standard-Style Type PM Motor Operator provides space for an RTU, radio and antenna, power supply, control power source and associated components.

Figure 3. Fast-Trip Style Type PM Motor Operator has a larger, high-speed motor and space to accommodate an array of communications and control components similar to the Standard-Style Motor Operator. Cover (with yellow label) over motor is interlocked so that when the cover is open, motor operation is blocked to prevent exposure to fast moving parts.

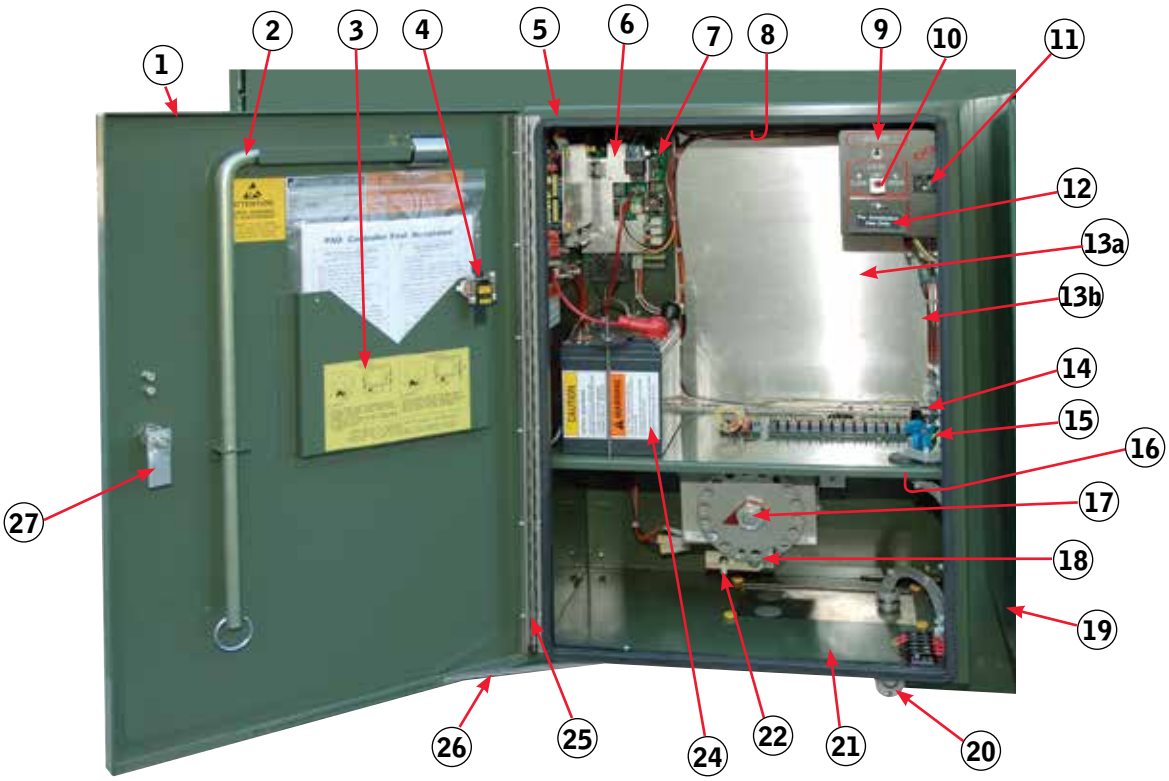


Figure 4. Features of Federal Pacific Standard-Style and Fast-Trip Style (Standard-Style is Pictured) Type PM Motor Operator.

1 **Aluminum Enclosure** – Heavy-gauge and corrosion resistant construction with door overlapping opening.

2 **Manual Switch-Operating Handle** – For use in the event that control power is lost - with storage provisions.

3 **Instruction Manual Storage Pocket** – Provides convenient holder for easy reference.

4 **Storage Clip for Spare Secondary Fuses** — Backup protection for vulnerable control circuits.

5 **Fully Gasketed Door Opening** – Combined with rigid construction and deep overlap of door provides protection from the environment.

6 **Control Module with LED Status** – Provides intelligence for controlling operations and status outputs.

7 **Power Module with Battery Charger** – Ensures availability of adequate control power for switching operations.

8 **Ribbon Cable Wiring System** – Simplifies interconnecting control wiring for easy identification and maintenance (on underside of roof).

9 **Local/Remote Selector Switch** – When in Local, allows operation at the unit while blocking remote operation; remote operation is enabled when in remote.

10 **Open/Close Operating Switch with Indicating Lamps** – Permits local electrical switching and annunciates switch position.

11 **Fused AC Receptacle** – Provides power outlet for connection of secondary load.

12 **Motor-Travel Set Controls** – Secured behind cover, allows adjustment of the travel limits for the motor operator.

13a **Mounting Plate** — Provides space for installation of RTU.

13b **Radio Provisions (radio by customer)** – Space permits installation of a radio for communication with a master station.

14 **Disconnecting Fuses** – Protect AC circuits and facilitate easy replacement.

15 **Smurff™ Surge Protector** – Provide surge protection for control circuits.

16 **Heater with Thermostat** – Keeps interior dry, eliminating potentially damaging moisture.

17 **Open/Close Motor-Position Indicator** – Semaphore target provides indication of actual motor position and switch position when coupled. See Figures 3 and 8 for picture of fast-trip style and additional features that may apply.

18 **Padlockable Motor Assembly** – Insures personnel security against inadvertent operation. See Figures 3 and 8 for picture of fast-trip style and additional features that may apply.

19 **Gasketing Shroud** – Seals motor-operator enclosure to pad-mounted switchgear enclosure (Not visible).

20 **Ground Connector** – On exterior of enclosure allows connecting enclosure to system ground.

21 **Removable Access Plate** – Allows installation of a knockout for entry of control wiring.

22 **Padlockable Decoupler Lever** – Facilitates testing of motor and controls while providing easy secure method of isolation for operating personnel. See Figures 3 and 8 for picture of fast-trip style and additional features that may apply.

23 **Padlock Tab**

24 **Battery with Venting Hose** – Maintains power availability for motor operation and control equipment.

25 **Stainless-Steel Door Hinge** – Continuous hinge ensures smooth door opening throughout unit life.

26 **Door Holder** – Secures door open.

27 **Stainless-Steel Door Handle & Latch** – Durable components that ensure easy operation.

28 **Key Interlock -** Coordinate access to fuse compartments by requiring switches to be open.

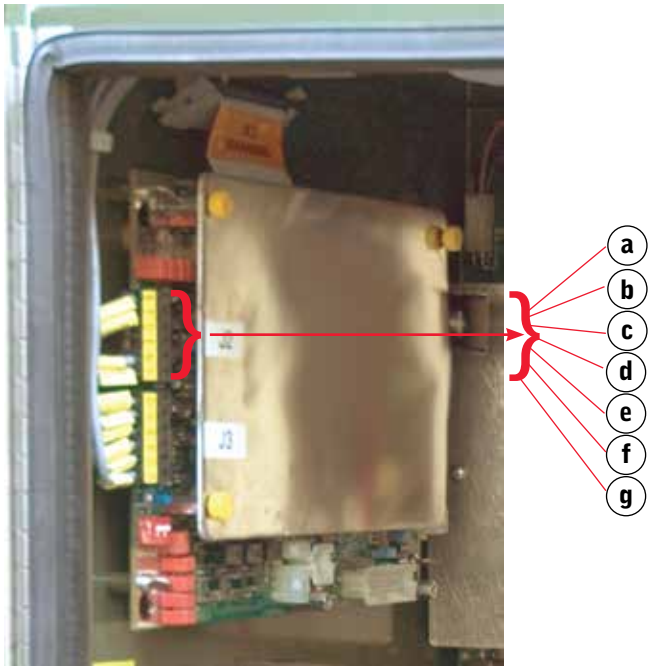


Figure 5. Control module with LED status lamps.

Status Outputs

a. Loss of AC Power/Loss of Charger Alarm
b. No-Go Alarm
c. Motor Open Status
d. Motor Closed Status
e. Low-Battery Alarm
f. Remote Status
g. Pushbutton

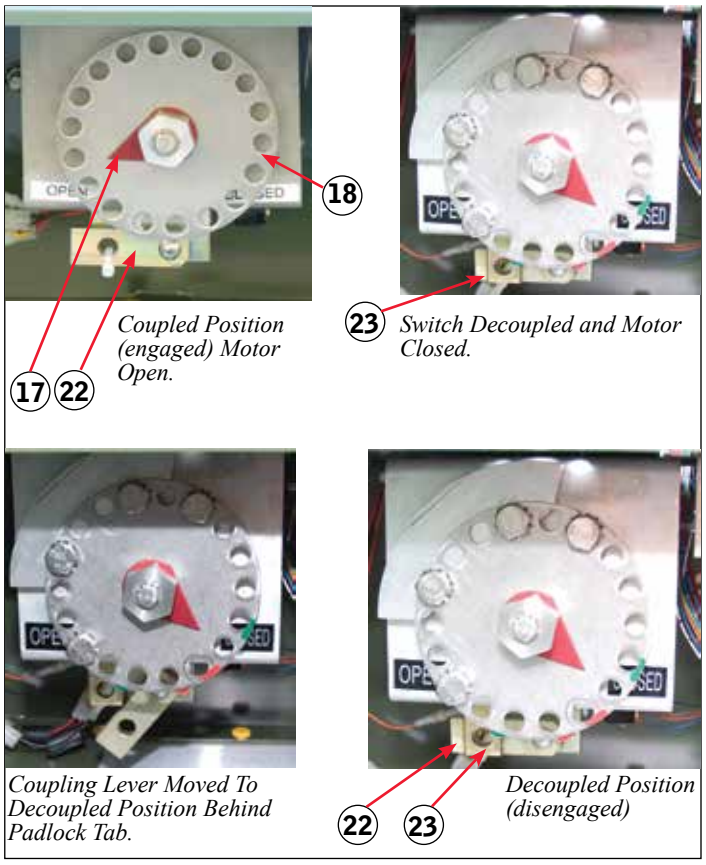


Figure 7. Padlockable motor and decoupler. Photo at top left shows decoupler in coupled (engaged) position. Photo at bottom right shows decoupler in decoupled (disengaged) position.

Figure 6. Panel with local controls and motor travel set controls.

Figure 8. Open door view of Fast-Trip Style Type PM Motor Operator showing motor and decoupler lever.

Notes

NON-LOADBREAK AND AUTO-JET® LOAD-BREAK FUSE MOUNTINGS

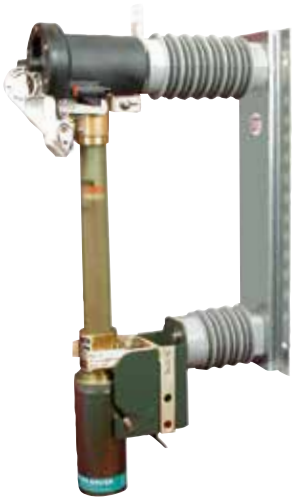
(All fuse-mounting base plates are galvanized steel)

NON-LOADBREAK FOR SM-4 REFILL UNIT
Shown With S&C SM-4Z Fuseholder

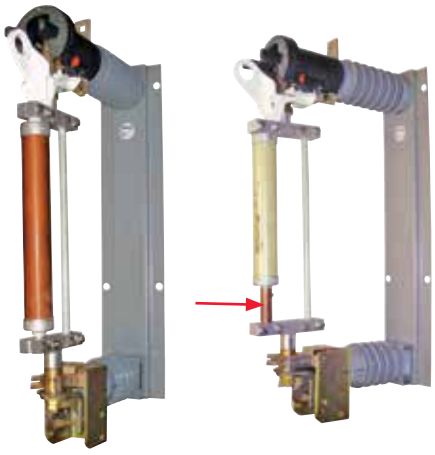
NON-LOADBREAK FOR DBU, CMU or SMU-20 FUSE UNITS
Shown With S&C SM-20 End Fittings

NON-LOADBREAK FOR SM-5 REFILL UNIT
Shown With S&C SM-5S Fuseholder

AUTO-JET® FOR SM-4 REFILL UNIT
Shown With S&C SML-4Z Fuseholders and includes positive latch indicator.



AUTO-JET® FOR CURRENT-LIMITING FUSE
Shown With AJ-NX type holders and includes positive latch indicator



without adapter with adapter

AUTO-JET® FOR SMU-20 or DBU FUSE UNIT
Shown With S&C SML-20 End Fittings same as Eaton DBU fuses and end fittings and includes positive latch indicator

LOAD-BREAK Auto-jet® fuse mountings feature the Federal Pacific EZ-Latch Mechanism with a positive-latch indicator and are available to accommodate S&C Types SM-4 and SMU-20, Eaton DBU, Cooper: Type NX, and (CT) Type X-Limiter in 15kV and 25kV class.

NON-LOADBREAK disconnect type fuse mountings are available to accommodate a choice of S&C Types SM-4 and SMU-20, Eaton DBU fuses in 15kV and 25kV class and S&C Type SM-5 fuses in 15kV, 25kV and 35kV class.

FP Fuse-Unit End Fittings

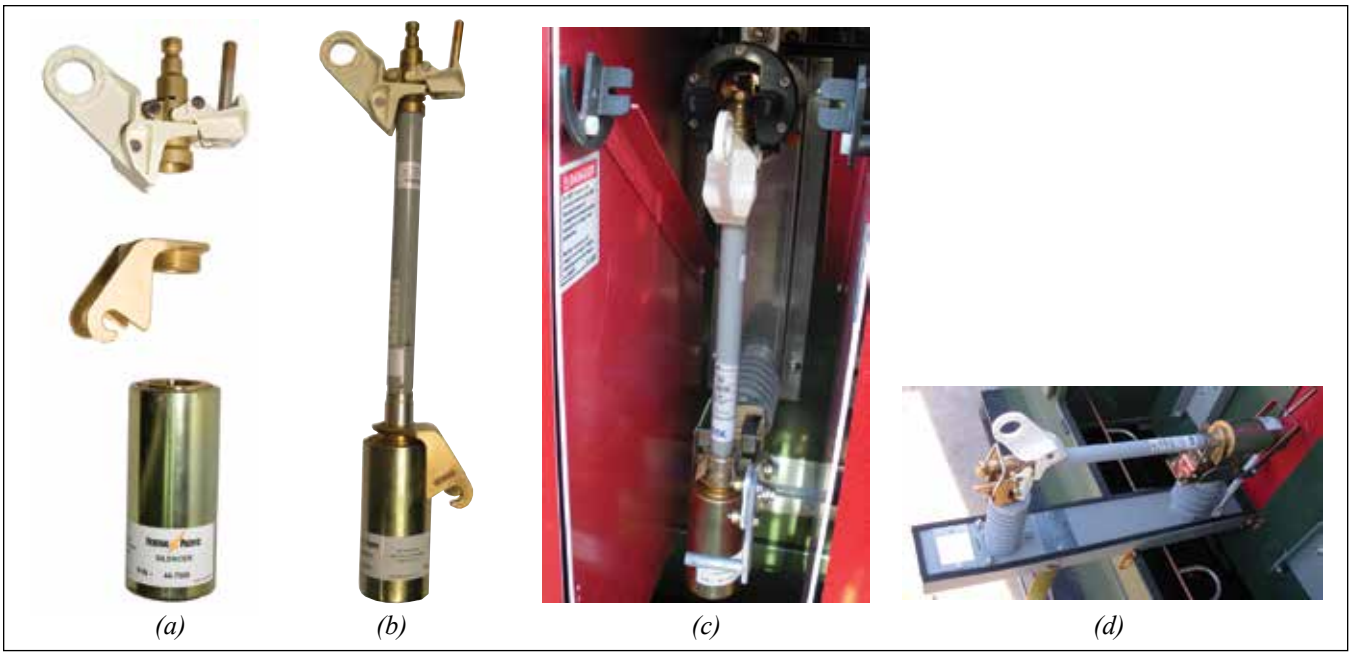


Figure 1. The individual components comprising the Federal Pacific Fuse-Unit End Fittings are pictured at (a); at (b) the components are pictured assembled on a fuse unit; and the combination is shown at (c) installed in a live-front fuse mounting and at (d) in a dead-front fuse mounting.

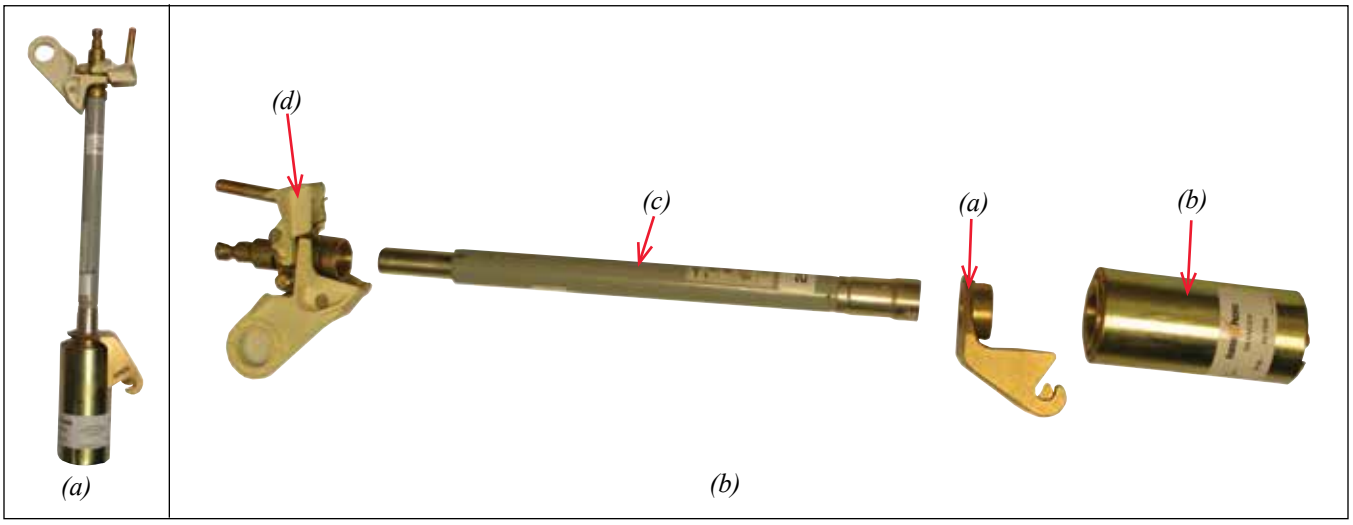


Figure 2. The complete fuse-unit-and-end-fitting assembly is pictured at (a) and the four individual components are illustrated at (b).

Fuse-Unit End Fittings - continued

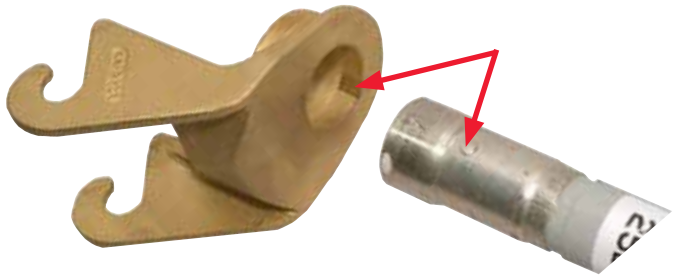


Figure 3. Federal Pacific's lower end-fitting trunnion casting has a guide slot that matches to the raised button on the fuse-unit lower-contact ferrule. The silencer/diffuser threads onto the trunnion casting.

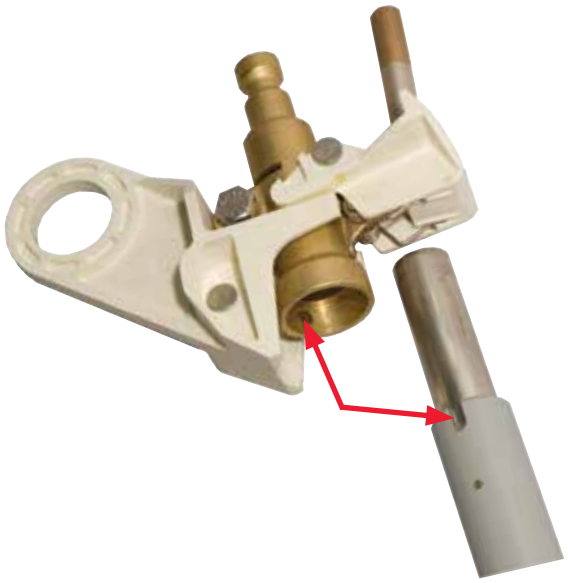


Figure 4. Federal Pacific's upper end-fitting casting has a raised button inside that matches to the guide groove adjacent to the fuse-unit upper-contact ferrule.

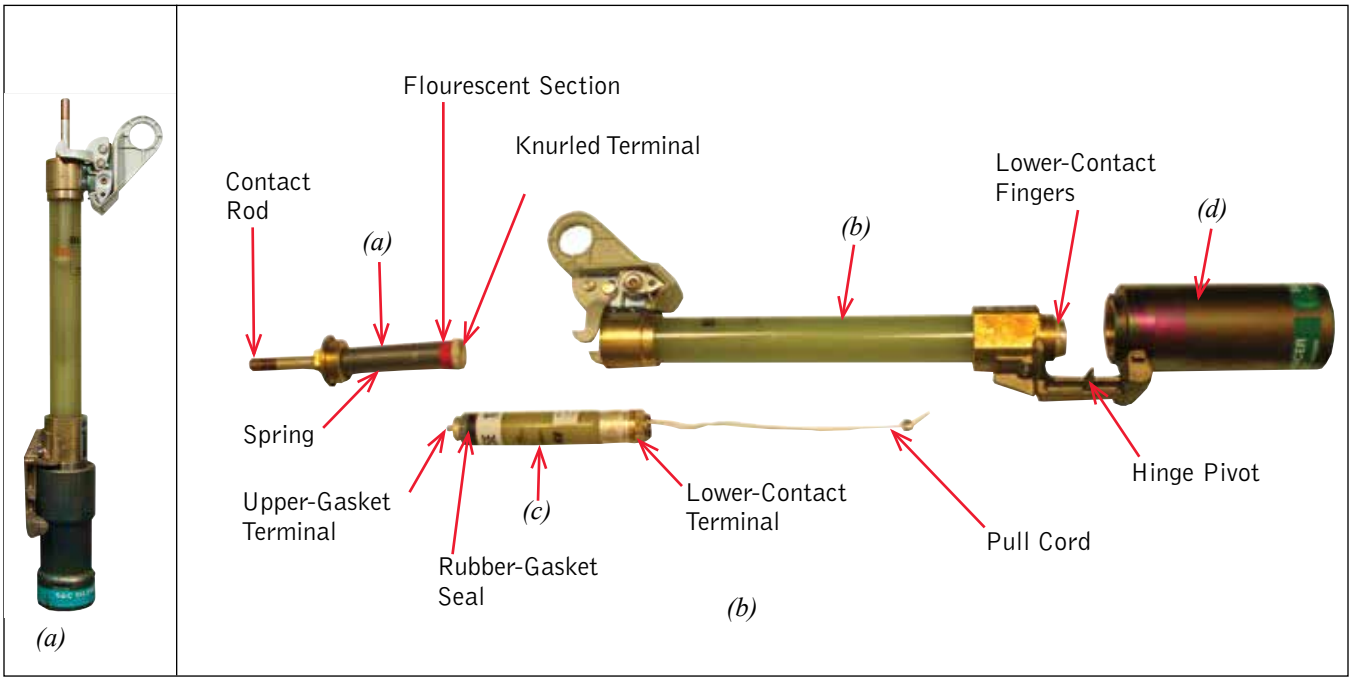


Figure 5. The complete refill-unit-and-fuse-holder assembly is pictured at (a) and the four individual components are illustrated at (b).

Application Data — Non-Loadbreak Disconnect

Fuse Manufacturer ①	Fuse-Unit or Refill Unit Type	Mounting (Including Live Parts) Catalog No. *	Ratings kV			Holder or End Fittings Catalog No. **	Fuse Ratings Amperes RMS ②		
			Nom.	Max. Des.	BIL		Max.	Interrupting SYM	Fault Close
S & C	SM-4	0025-2-03071†	14.4	17.0	95	88632R2	200	12,500	N/A
		0025-2-03070 ■	14.4	17.0	95	86632R2	200	12,500	N/A
	SMU-20	33-7027 ■	14.4	17.5	95	FP-3097	200	14,000	N/A
		33-7059 ■	25	27	125	FP-3097	200	12,500	N/A
		33-7062 ■	34.5	38	150	FP-3097	200	8,450	N/A
	SM-5S	33-7028 ■	4.8	5.5	60	86641R2 ③	400	27,000 ⑤	N/A
		0025-2-03063	14.4	17.0	95	86642R2 ④	400	25,000	N/A
		0025-2-03064	25	27	125	86643R2 ④	300	20,000	N/A
		0025-3-03087	34.5	38	150	86644R2	300	17,500	N/A
Eaton	DBU	33-7027 ■	14.4	17.5	95	FP-3097	200	14,000	N/A
		33-7059 ■	25	27	125	FP-3097	200	12,500	N/A
Cooper	CMU	33-7027 ■	14.4	17.5	95	FP-3097	200	14,000	N/A
		33-7059 ■	25	27	125	FP-3097	200	12,500	N/A

* Less holder/end fittings
** Includes silencer or snuffler as applicable.
† Bus for cable termination on left side of mounting.
■ Bus for cable termination on right side of mounting.

① For fuse application and ordering information refer to applicable S&C and Eaton publications.

② Fuse mountings are non-loadbreak.

③ Rated 7.2 kV nominal, for use in listed 4.8 kV mountings for system voltages through 4.8 kV.

④ Rated 14.4 kV nominal, for use in listed 13.8 kV mountings.

⑤ Applies to 7.2 kV refill unit in 7.2 kV holder for 4.8 kV system voltage only. Rating is 37,500 amperes rms symmetrical for 4.16 kV refill unit in 7.2 kV holder for system voltages through 4.16 kV.

Application Data — Load-break Disconnect

Fuse Manufacturer	Fuse Unit or Refill Unit Type	Mounting (Including Live Parts) Catalog No. ①	Ratings kV			Holder or End Fittings (Including Silencer) Catalog Number	Fuse Ratings Amperes RMS			
			Nom.	Max. Des.	BIL		Max.	Loadbreak	Interrupting SYM	3-Time Fault-Close ② ASYM ③
S & C	SM-4	34-9057 ▲	14.4	17.0	95	92352	200	200	12,500	20,000
		34-9056 ♦	14.4	17.0	95	92352	200	200	12.500	20,000
		34-9055 ▲	25	27	125	92353	200	200	12.500†	20,000
		34-9054 ♦	25	27	125	92353	200	200	12.500†	20,000
	SMU-20	34-9047 ▲	14.4	17.5	95	FP-3097	200	200	14,000	22.400
		34-9046 ♦	14.4	17.5	95	FP-3097	200	200	14,000	22,400
		34-9023 ▲	25	27	125	FP-3097	200	200	12,500	20,000
		34-9022 ♦	25	27	125	FP-3097	200	200	12,500	20,000
Eaton	DBU	34-9047 ▲	14.4	17.5	95	FP-3097	200	200	14,000	22,400
		34-9046 ♦	14.4	17.5	95	FP-3097	200	200	14,000	22,400
		34-9023 ▲	25	27	125	FP-3097	200	200	12.500	20,000
		34-9022 ♦	25	27	125	FP-3097	200	200	12,500	20,000
Cooper ④⑤	NX	34-7101 ▲●	14.4	17.0	95	0021-2-03055 ●	⑥	⑧	50,000	40,000
		34-7101-01 ♦	14.4	17.0	95	0021-2-03055 ●	⑥	⑧	50,000	40,000
		0025-3-03058 ▲●	25	27	125	0021-2-03055 ●	⑦	⑧	50,000	40,000
		0025-3-03059 ♦●	25	27	125	0021-2-03055 ●	⑦	⑧	50,000	40,000
Cooper	CMU	34-9047 ▲	14.4	17.5	95	FP-3097	200	200	14,000	22,400
		34-9046 ♦	14.4	17.5	95	FP-3097	200	200	14,000	22,400
		34-9023 ▲	25	27	125	FP-3097	200	200	12,500	20,000
		34-9022 ♦	25	27	125	FP-3097	200	200	12,500	20,000

● For Code 6 fuses only. For Code 5 fuses, also specify adapter Part No. AA5519.

▲ Bus for cable termination on left side of mounting.

♦ Bus for cable termination on right side of mounting.

† Applicable to solidly grounded neutral systems only with fuses connected by single-conductor, concentric-neutral type cable to a transformer or transformers. Rating is 9,400 amperes RMS symmetrical, 15,040 amperes RMS asymmetrical (405 MVA) for all other applications.

① Less Holder and less end fittings as applicable.

② Three-time fault-close rating: The Auto-jet® II fuse mounting can withstand a fuse holder or fuse end fitting being closed into a fault of the magnitude specified three times when closed briskly without hesitation and remain operable and able to carry and interrupt the continuous current. (Must replace fuse after each interruption.) Refer to Federal Pacific instruction manual on FP-3097 end fittings, S&C instruction manual for SML-4Z holder and SML-20 end fitting maintenance required after each fault close or fault interruption).

③ Ratings express in RMS amperes asymmetrical are 1.6 times the symmetrical values listed.

④ For Cooper (CT) X-Limiter fuses, refer to factory.

⑤ Mountings

a. Part No. 0025-3-03058 and 59, 25kV, 125kV.

b. Part No. 34-7101 and 34-7101-01, 15kV, 95kV BIL accepts code 6 fuses direct. Code 5 fuses require adapter Part No. AA5519.

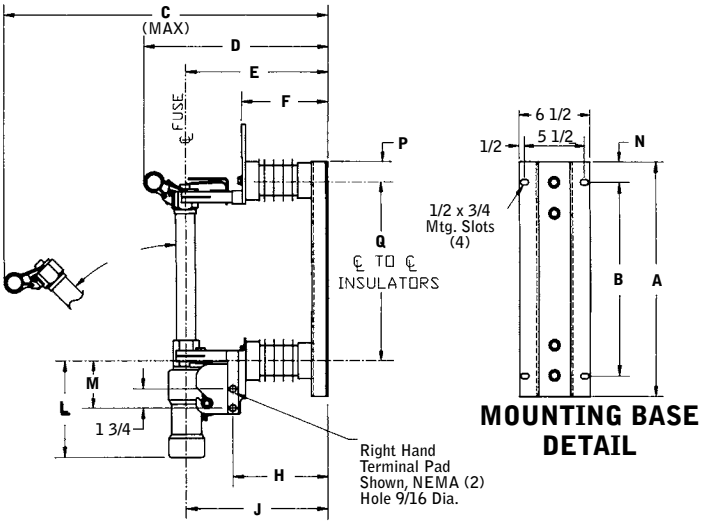
⑥ NX fused units: Auto-jet® II fuse mountings will accommodate one 100 ampere Cooper type NX current-limiting fuse rated 8.3kV, one 100 ampere fuse rated 13.5kV, or one 80 ampere fuse rated 15kV. Three sets of Auto-jet® II end fittings and three appropriately rated fuses are required in each fuse compartment.

⑦ NX fused units: Auto-jet® II fuse mountings will accommodate one 100 ampere Cooper type NX current-limiting fuse rated 13.5kV, one 80 ampere fuse rated 15kV, one 40 ampere fuse rated 23kV, or one 50 ampere fuse rated 27kV. Three sets of Auto-jet® end fittings and three appropriately rated fuses are required in each fuse compartment.

⑧ Load-break rating same as maximum continuous current rating. For fuse application and ordering information refer to the applicable S&C, Cooper or Eaton fuse publication.

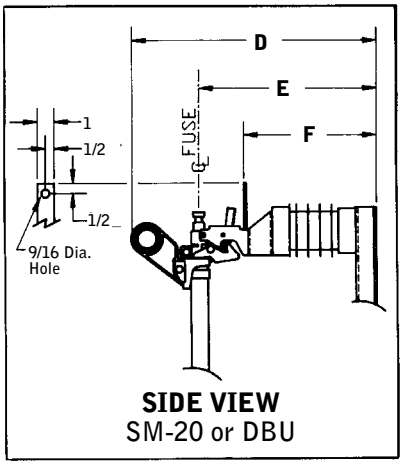
Dimensions: Auto-jet® Non-Loadbreak Fuses

Dimensions not to be used for construction purposes.
Refer to the factory for detailed construction drawings.

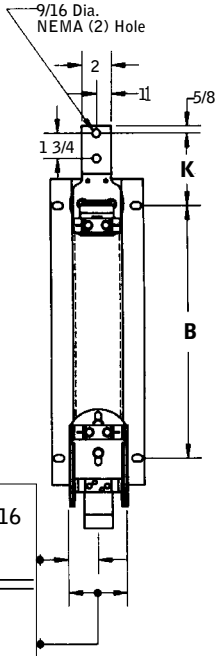


FRONT VIEW
(EE-4Z, EE-5S)

MOUNTING BASE DETAIL



SIDE VIEW
SM-20 or DBU



SM-20, DBU or CMU	1-11/16
SM-4	2
SM-5	2-9/16
SM-20, DBU or CMU	3-3/8
SM-4	4
SM-5	5-1/8

FRONT VIEW
(Fuse Removed)

kV Class	kV BIL	Fuse Unit Type	Mounting Catalog Number *	Dimensions in Inches													
				A	B	C	D	E	F	G	H	J	K	L	M	N	P
15	95	SM-4	0025-3-03071 †	22-1/2	18-7/16	30-9/16	15-15/16	11-15/16	7-13/16	16-1/2	8-3/4	13-1/2	4-5/8	8-5/8	4-5/16	2	2
15	95		0025-3-03070 ■	22-1/2	18-7/16	30-9/16	15-15/16	11-15/16	7-13/16	16-1/2	8-3/4	13-1/2	4-5/8	8-5/8	4-5/16	2	2
15	95	SMU-20 or DBU or CMU	33-7027 ■	23-3/4	17-3/4	31-7/8	17-5/8	12-5/8	9	18	8-1/8	13	5-3/8	8	3-13/16	4-1/8	1-3/4
25	125		33-7059 ■	25-3/4	22-1/4	35-3/16	19-3/16	14-7/16	10-9/16	20-3/4	9-11/16	14-7/16	3	8	3-13/16	1-3/4	1-3/4
35	150		33-7062 ■	33-1/8	28-1/4	43	22	17-1/4	13-3/4	28-1/4	12-7/8	17-1/4	1-7/8	8	3-13/16	1-3/4	2-7/8
5	60	SM-5	33-7028	24	17-3/4	31-13/16	17-13/16	12-13/16	9-1/8	12-1/2	10-1/16	12-11/16	6-15/16	11	6-1/16	4-3/8	2-1/16
15	95		0025-2-03063	21-1/2	18-7/16	34-9/16	17-13/16	12-13/16	8-3/16	16-1/2	9-3/16	12-11/16	4-5/8	11	6-1/16	2	2
25	125		0025-2-03064	25-3/4	22-11/16	39-1/4	19-3/8	14-3/8	9-3/4	20-3/4	10-3/4	14-1/4	4-5/8	11	6-1/16	2	3
35	150		0025-3-03087	34-3/16	26-3/4	45-15/16	22-3/16	17-3/16	15-3/4	28	16-3/4	16-15/16	4-5/8	11	6-1/16	2	2

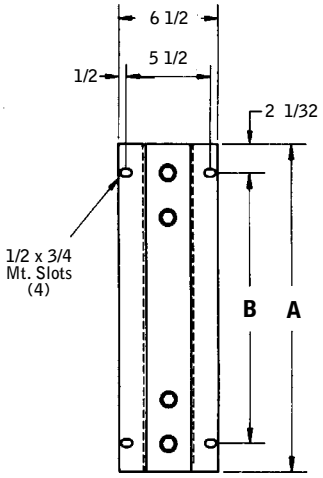
* Holders/End Fittings and Fuse Unit/Refills not included.

† Bus for cable termination on left side of mounting.

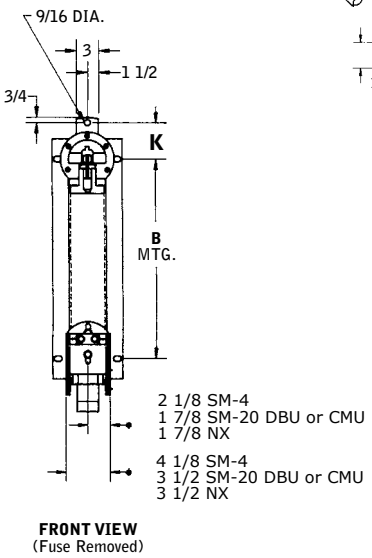
■ Bus for cable termination on right side of mounting.

Dimensions: Auto-jet® Load-break Fuses

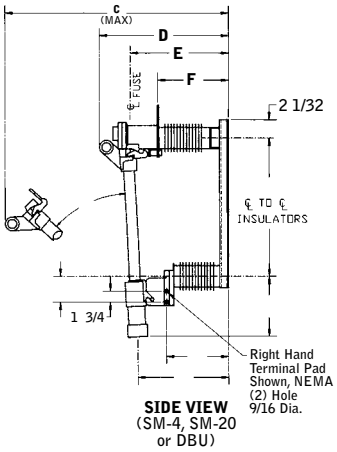
Dimensions not to be used for construction purposes.
Refer to the factory for detailed construction drawings.



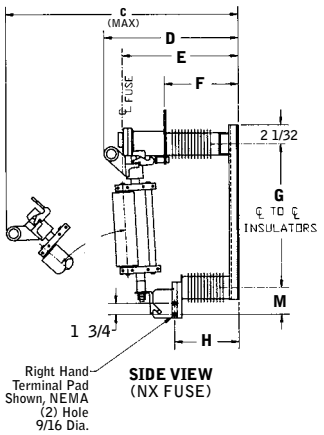
MOUNTING BASE DETAIL



FRONT VIEW
(Fuse Removed)



SIDE VIEW
(SM-4, SM-20
or DBU)



SIDE VIEW
(NX FUSE)

kV Class	kV BIL	Fuse Unit Type	Mounting Catalog Number *	Dimensions in Inches											
				A	B	C	D	E	F	G	H	J	K	L	M
15	95	SM-4	34-9057 ▲	22-1/2	18-7/16	30-3/4	17-3/4	12-3/4	9-1/4	18-7/16	8-1/4	12-1/4	3	8-5/8	4-3/8
15	95		34-9056 ◆	22-1/2	18-7/16	30-3/4	17-3/4	12-3/4	9-1/4	18-7/16	8-1/4	12-1/4	3	8-5/8	4-3/8
25	125		34-9055 ▲	26-3/4	22-11/16	36	20	14-3/4	11-9/16	22-11/16	10-9/16	14-1/2	3	8-5/8	4-3/16
25	125		34-9054 ◆	26-3/4	22-11/16	36	20	14-3/4	11-9/16	22-11/16	10-9/16	14-1/2	3	8-5/8	4-3/16
15	95	SM-20	34-9047 ▲	23-1/16	18-7/16	30-1/2	19-1/4	14-1/4	9-1/4	19-1/16	9-7/16	13-7/16	3	8	3-13/16
15	95		34-9046 ◆	23-1/16	18-7/16	30-1/2	19-1/4	14-1/4	9-1/4	19-1/16	9-7/16	13-7/16	3	8	3-13/16
25	125		34-9023 ▲	25-3/4	22-11/16	34-5/8	21-13/16	16-3/4	11-9/16	22-11/16	11-3/4	15-1/16	3	8	3-13/16
25	125		34-9022 ◆	25-3/4	22-11/16	34-5/8	21-13/16	16-3/4	11-9/16	22-11/16	11-3/4	15-1/16	3	8	3-13/16
15	95	DBU or CMU	34-9047 ▲	23-1/16	18-7/16	30-1/2	19-1/4	14-1/4	9-1/4	19-1/16	9-7/16	13-7/16	3	8	3-13/16
15	95		34-9046 ◆	23-1/16	18-7/16	30-1/2	19-1/4	14-1/4	9-1/4	19-1/16	9-7/16	13-7/16	3	8	3-13/16
25	125		34-9023 ▲	25-3/4	22-11/16	34-5/8	21-13/16	16-3/4	11-9/16	22-11/16	11-3/4	15-1/16	3	8	3-13/16
25	125		34-9022 ◆	25-3/4	22-11/16	34-5/8	21-13/16	16-3/4	11-9/16	22-11/16	11-3/4	15-1/16	3	8	3-13/16
15	95	NX **	34-7101 ▲	30-7/16	18-7/16	30-1/2	19-1/4	16-1/4	9-1/4	26-1/16	9-7/16	N/A	3	N/A	3-13/16
15	95		34-7101-01 ▲	30-7/16	18-7/16	30-1/2	19-1/4	16-1/4	9-1/4	26-1/16	9-7/16	N/A	3	N/A	3-13/16
25	125		0025-3-03058 ▲●	29-7/16	22-11/16	34-5/8	21-13/16	18-3/4	11-9/16	25-3/8	10-3/16	N/A	3	N/A	3-3/4
25	125		0025-3-03059 ◆●	29-7/16	22-11/16	34-5/8	21-13/16	18-3/4	11-9/16	25-3/8	10-3/16	N/A	3	N/A	3-3/4

● For Code 6 fuses only. For Code 5 fuses, also specify adapter Part No. AA5519.
▲ Bus for cable termination on left side of mounting.
◆ Bus for cable termination on right side of mounting.

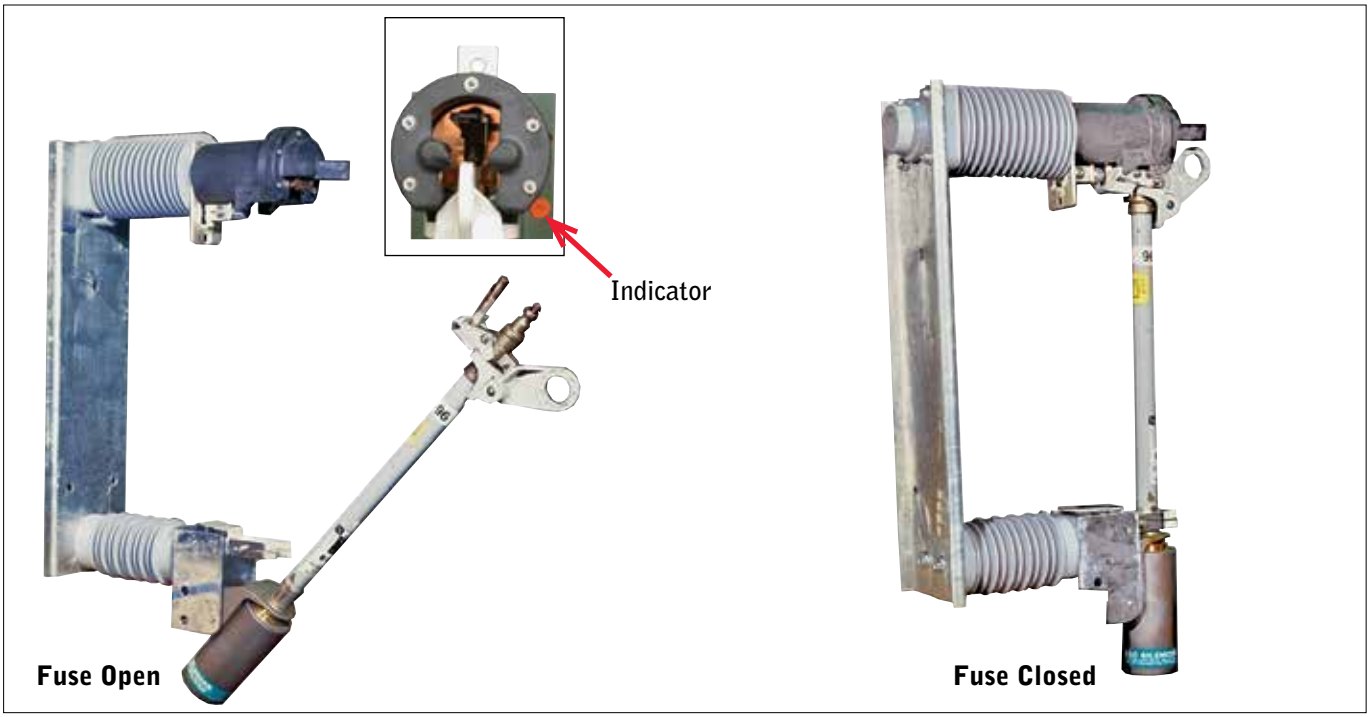
*Holders/End Fittings and Fuse Unit/Refills not included.

**The 15kV NX fuse mountings use Code 5 or 6 fuses, order fuse adapters when using code 5 fuses in this mounting.

The 25kV NX fuse mountings use 23kV or 15.5kV Code 6 Fuses.

Notes

FRONT CONNECTED AJ-20 AUTO-JET® LOAD-BREAK FUSE MOUNTINGS



Accomodates FP-3097 End Fittings and S&C SMU-20 Fuse Unit and also accomodates the Eaton DBU or Cooper CMU and S&C SML-20 fuse and end fittings. Fuse mounting plate is galvanized steel and fuse hinge is electrostatically plated with a hard durable yellow dichromate finish passes "Enclosure Coating System" Section 5 of ANSI C57.12.28. Inset shows positive latch indicator with red target extended, indicating that fuse is fully closed and latched.

Fuse Ratings					
Fuse Manufacturer and Type	Amperes RMS				Three-Phase MVA SYM
	Max. Cont.	Load-break ①	Interrupting SYM	Momentary & Three-Time Fault-Close ASYM ②③④	
At 14.4 Nominal Voltage • 95kV BIL					
S&C SM-4	200	200	12,500	20,000	310
Eaton DBU Cooper CMU and S&C SMU-20	200	200	14,000	22,400	350
At 25kV Nominal Voltage • 125kV BIL					
S&C SM-4	200	200	12,500	20,000	540
Eaton DBU Cooper CMU and S&C SMU-20	200	200	12,500	20,000	540

① In conjunction with Auto-Jet® Fuse Mountings.

② Ratings expressed in RMS amperes asymmetrical are 1.6 times the symmetrical values listed.

③ Unit overall ratings are limited to the lowest component rating. Ratings shown are for fuse mounting interrupter device.

④ Three-time fault-close rating: The Auto-Jet® fuse mounting can withstand a fuseholder or fuse with end fitting being closed into a fault of the magnitude specified three times when closed briskly without hesitation and remain operable and able to carry and interrupt the rated continuous current. (Must replace fuse after each interruption.) Refer to Federal Pacific instruction manual on FP-3097 end fittings, S&C instruction manual for SML-4Z holder and SML-20 end fitting and Eaton DBU instructions for maintenance required after each fault close or fault interruption.)

Auto-Jet® Load-break Fuse

The Auto-Jet® fuse mounting has an integral stored-energy load-break device that permits single-pole live switching in single-phase or three-phase circuits by the use of an ordinary hotstick. In addition, when the fuse is fully inserted and positively latched, the EZ-Latch mechanism has a positive-latch indicator that provides a semaphore that extends. The integral load interrupter has a three-time fault-close duty cycle when, without hesitation, the fuse is briskly closed. The overall unit rating may be limited by the fuse rating.

Illustration of Auto-Jet® Fuse Interrupter

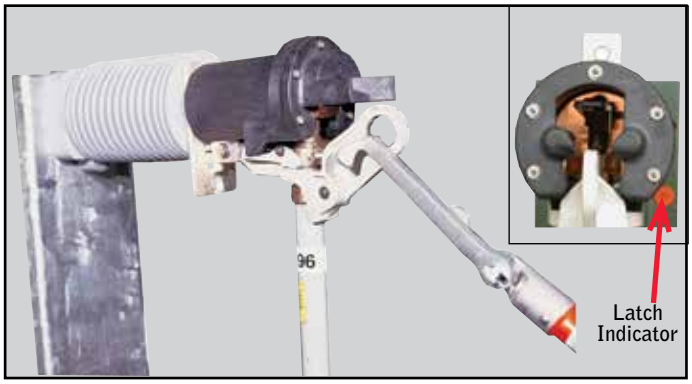


Figure 1. Closed: Positive Latch Indicator Extended (see inset). Hookstick Ready To Open.

Figure 2. Main Contacts Have Parted, Puffer Spring Charged, and Interrupter Parted.

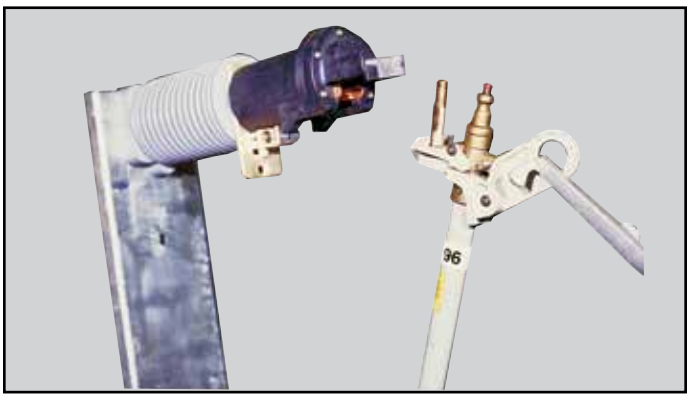


Figure 3. Holder Parted, Auto-jet® Reset For Next Closing Operation. Positive Latch Indicator Retracted and Out of View.

The same unique laminated air jet interrupter system used in the three-pole group-operated switches is applied in the Auto-Jet® load-break fuse mountings.

Figures 1 through 3 shown below illustrate the basic operation of the Auto-Jet® Interrupter device.

Load-break Fuse Operation

1. Insuring latched fuse, verify extended Positive Latch Indicator. Install grappler tool in pull ring of fuse end fitting as shown. (Figure 1)
2. Pull the fuse open with a single sharp continuous motion to the fully open position (45°). Maintain downward force on fuse pull ring until fuse opening motion has ceased. This downward force will prevent tendency for fuse to bounce toward the closed position.

Caution: Do not assume that an open fuse position indicates the fuse to be de-energized.

3. Re-install grappler onto fuse assembly with the cone positioned in the pull ring on the upper end fitting and with the fingers of the grappler tool cradling the tube of the fuse unit. Then, while grasping the hotstick firmly, lift fuse assembly up and out of mounting.
4. Re-fuse using procedures as included with replacement fuse unit.
5. Re-install grappler onto fuse assembly and place fuse assembly into fuse mounting in the 45° open (disconnect) position.
6. Insert grappler prong into fuse pull ring and, while maintaining a downward force on the fuse pull rings, push briskly on the fuse assembly, completing the closing stroke in one motion.
7. Before removing grappler from fuse pull ring, verify that the Positive Latch Indicator is extended indicating that the fuse is fully latched. If the indicator is not extended (DO NOT PULL OPEN), push firmly until the latch indicator target extends to assure that the fuse is completely closed and latched.

Components Purchased Separately

14.4kV Nominal

SM-4 fuse mounting requires one S&C Cat. No. 92352 SML-4Z fuseholder and one S&C SM-4 fuse refill.

SM-20 or DBU fuse mounting requires one set of Federal Pacific FP-3097 end fittings or S&C Cat. No. 3097 SML-20 fuse end fittings and one S&C SMU-20 fuse unit or one set of Federal Pacific FP-3097 end fittings or Eaton DBU Cat. Number DBU-EFID end fittings and one DBU fuse unit.

25kV Nominal

SM-4 fuse mounting requires one S&C Cat. No. 92353 SML-4Z fuseholder and one S&C SM-4 fuse refill.

SMU-20 or DBU fuse mounting requires one set of Federal Pacific FP-3097 end fittings or S&C Cat. No. 3097 SML-20 fuse end fittings and one S&C SMU-20 fuse unit or one set of Federal Pacific FP-3097 end fittings or Eaton DBU Cat. Number DBU-EFID end fittings and one DBU fuse unit.

FEDERAL PACIFIC EPOXY
INSULATORS AND BUSHINGS

Federal Pacific switch and bus insulators, bushings, and bushing wells made from the highest quality cycloaliphatic epoxy resins and selected fillers to achieve an optimum balance of electrical and mechanical characteristics. Standard color is skytone gray.

Shown below are minimum test values for Federal Pacific insulators, bushings, and bushing wells, obtained during independent electrical and mechanical testing in accordance with the applicable test methods specified by the latest edition of ANSI C29.1 and ANSI 386.

INSULATORS

Federal Pacific EEpoxy™ insulators are made to the exacting requirements of ANSI C29.1 and are recommended for switch and bus applications which require superior arc and track resistance, excellent mechanical strength, exceptionally high leakage (creep) distance for contamination resistance and self-scouring, non-weathering performance.

Each Federal Pacific EEpoxy™ Class A insulator is equipped with eight aluminum 3/8" - 16 full-threaded inserts 3/4" deep, four on each end, in the standard 2" bolt circle. Standard color is Skytone Gray.

BUSHING WELLS AND BUSHINGS

Federal Pacific bushings and bushing wells meet all the design criteria in ANSI 386. By meeting this standard, all Federal Pacific bushings and bushing wells will interface with matching load-break and non-loadbreak inserts and elbows. The XL bushings and bushing wells feature a removable stud and include four aluminum inserts in a 3-inch square pattern on the interface end and two inserts in a 2-inch bolt circle centered on the 1/2-inch diameter tapped conductor rod on the bus end. The XM bushings and bushing wells are similar except the interface end, clamped to the mounting surface in a 3-bolt pattern using stainless steel plate and hardware.

Mechanical and Electrical Ratings

Components →	Insulators				200A Bushing Wells					600A Bushings			
Description →	EEpoxy 44-2701	EEpoxy 0054-3-02714	EEpoxy 0054-3-02723*	EEpoxy 0054-3-02716	EEpoxy 0028-4-02719	EEpoxy 0028-4-02720	XL 44-0271	XM 44-03201 ♦	XM-44-3202 ♦	XL 44-0264	XL 44-0276	XM 44-3203 ♦	XM 44-3204 ♦
Design Parameter ↓													
Voltage													
Nominal, kV	15	25	25	35	8.3	15.2	15	15	25	15	25	15	25
Max Design, kV	17	27	27	38	—	—	17	17	27	17	27	17	27
BIL, kV	95	125	135	150	95	125	95	95	125	95	125	95	125
Dimensions													
Leakage Distance, Inches	13.65	18.3	21.0	27.5	15.4	20.9	19	16-19/92	23-11/16	19	28-3/4	16-19/32	23-11/16
Height, Inches, Dim. "L"	6	7.56	8.25	10.23	7.5	9.0	6-1/4	6-3/8	8-5/8	6-1/4	8-1/2	6-3/8	8-5/8
Mechanical Ratings													
Cantilever, Ultimate 2.5" above top, Pounds	1,250	1,100	1,100	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
Tensile, Pounds	3,000	3,000	3,000	3,000	2,500	2,500	3,000	3,000	3,000	3,000	3,000	3,000	3,000
Torsion, Inch Pounds	3,500	3,500	3,500	3,500	540	540	540	540	540	2,000	2,000	540	540
Compression, Pounds	20,000	20,000	20,000	20,000	N/A	N/A	10,000	10,000	10,000	10,000	10,000	10,000	10,000
Net Weight, Pounds (Approx.)	3.5	4.3	4.5	5.5	4.3	5.3	7	3	3.5	11	13.5	5	5.5

*Available when creepage distance more than 18.3" is required.
† Tensile and torsion force applied to bushing-well conductor stud.
♦ Catalog number applies to bushing well or bushing only. For clamp ring and mounting hardware, add suffix "-01" to catalog number.

FP Cyclo-Aliphatic Epoxy

Federal Pacific insulators manufactured from cycloaliphatic epoxy resins in the Federal Pacific switchgear plant by the automatic pressure gelation APG) process; developed in Switzerland over fifty years ago, and widely used globally. It has developed to a technologically advanced state used in the manufacture of a broad range of indoor and outdoor high-voltage electrical components.

In this process, the cycloaliphatic epoxy resin hardener and various pre-mixed fillers and additives for properties and process control are combined in specially designed, computer-controlled equipment; formulations are developed by supplier engineers through exhaustive testing and field experience. The insulators and bushings are designed to meet precise requirements for a specific application. These formulations are balanced for high-voltage, high strength, non-tracking, self-scouring, non-weathering applications in extremes of high temperature and sub-zero cold.

The mix is thoroughly degassed under high vacuum and transferred to automatic presses. Here it is injected into highly-polished tool steel molds and formed under heat and pressure into compact, high leakage-distance, engineered thermoset contours to enhance the electrical and mechanical characteristics. Firmly imbedded in each end are full-threaded inserts as specified.

The cycloaliphatic epoxy components develop a high degree of polymer cross-linking to give optimum thermal, mechanical and electrical properties. All epoxy components are x-rayed, visually inspected for surface irregularities, color, integrity, and general appearance, and are serialized.

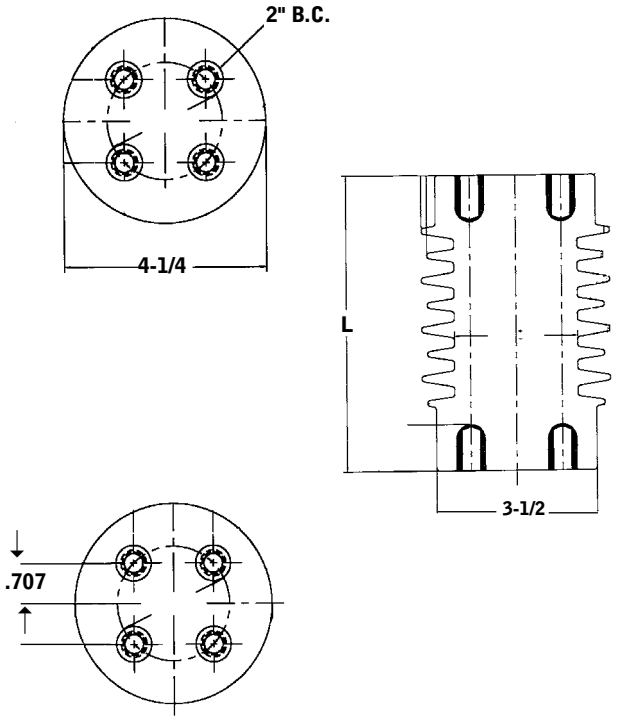
The in-process examination is given using a 110kV real time fluoroscopic x-ray for a 100 percent, 360°, end-to-end inspection. Trained examiners look for any signs of internal voids, cracks, non-bonded inserts or other defect that could cause or lead to problems under voltage, thermal or mechanical stress in future years.

Only after this rigidly controlled manufacturing process, x-ray inspection and any final de-flashing or cleaning which might be required are the insulators stamped "X-ray OK" and logged by serial number in quality assurance records – assurance that the Federal Pacific quality is locked in.

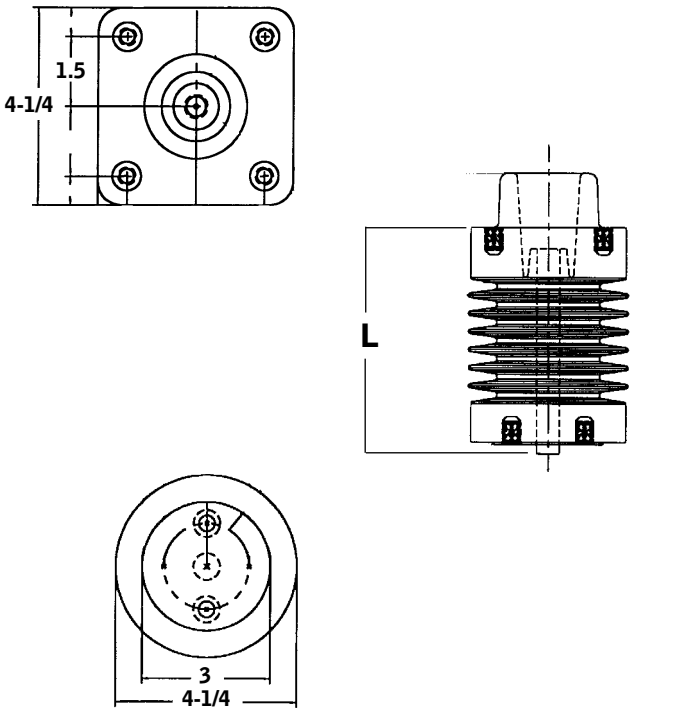
Finished insulators are 100%, 360°, end-to-end fully inspected internally by 100kV real-time fluoroscopic x-ray.

Federal Pacific cycloaliphatic epoxy insulators provide superior performance, serving as bus supports, interrupter housings, bushings and bushing wells on 5kV through 38kV products.

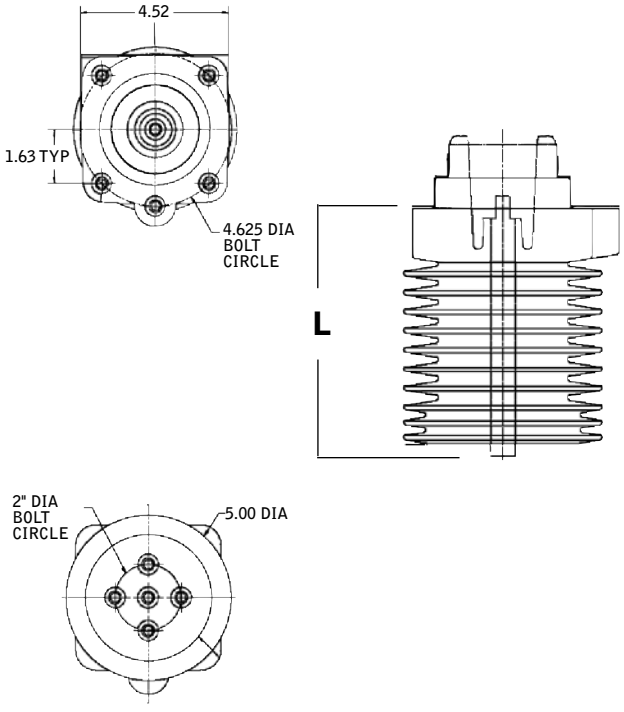
EEpoxy Insulators



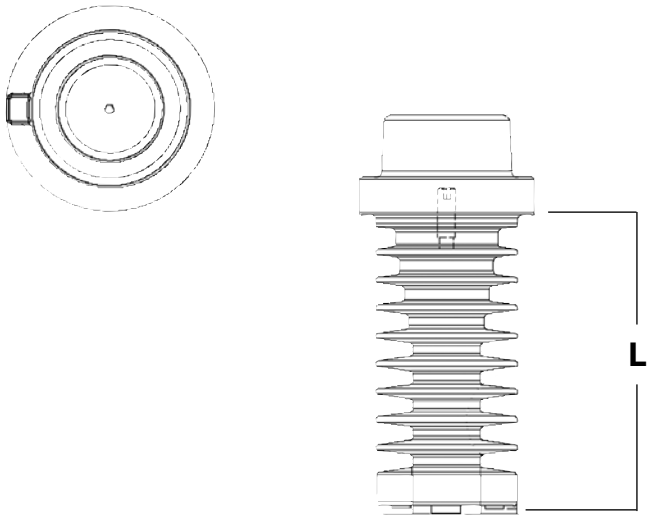
EEpoxy Bushing Wells



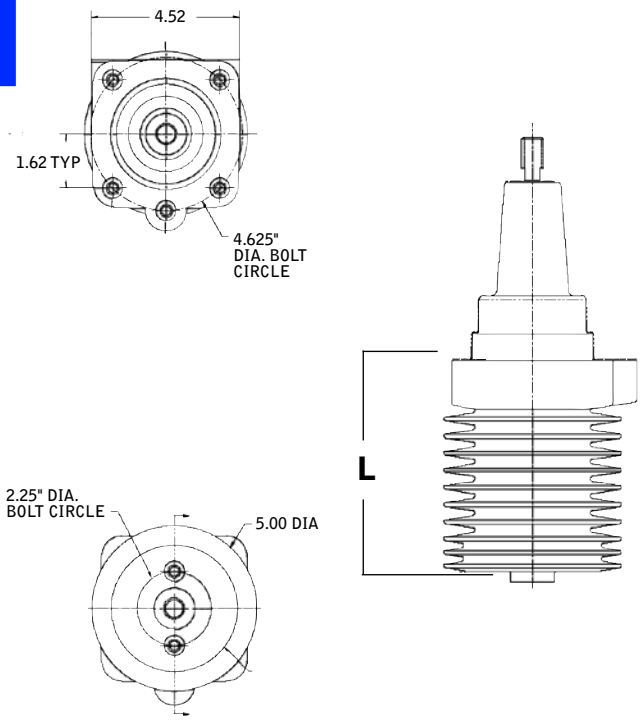
XL Bushing Wells



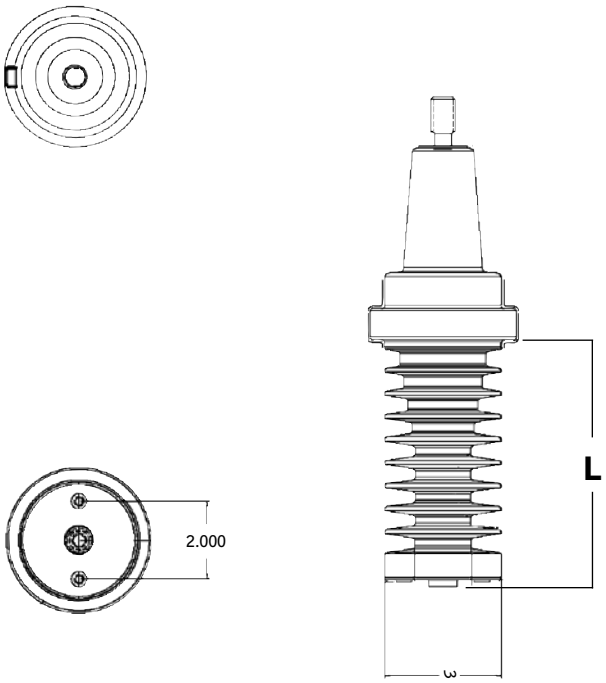
XM Bushing Wells



XL Bushings



XM Bushings



TERMS AND CONDITIONS OF SALE

These terms shall control the sale of all products of Electro-Mechanical Corporation and its divisions: Federal Pacific Company, Federal Pacific Transformer Company, Line Power Manufacturing Corporation, Electric Motor Repair and Sales, and PRJ (herein collectively "The Seller"). Purchaser's order is expressly subject hereto, and Purchaser accepts these Terms and Conditions which may not be changed except in writing signed by an authorized official of the Seller. Additional or different terms in any documents or communication from Purchaser are objected to by Seller and shall not be effective unless expressly agreed to in writing by an authorized official of Seller.

Warranties: Seller warrants that the product(s) to be delivered will be of the kind and quality described in its quotation and that Purchaser shall take good and merchantable title. Services rendered shall be performed in a workmanlike manner and shall comply with industry standards and/or customer specifications. No other warranties, express, or implied, shall arise from this transaction. If a deviation from the specifications in the quotation appears within the warranty period, the Purchaser shall notify the Seller immediately. Upon notice and confirmation of the defect, Seller agrees to remedy, F.O.B. factory, all such defects by repair or replacement of the defective parts without charge. The warranty shall not cover "in and out" charges, which shall remain the responsibility of the Purchaser.

THIS WARRANTY SHALL BE IN LIEU OF ALL OTHER WARRANTIES OF ANY SORT, EXPRESS OR IMPLIED, NOTWITHSTANDING ANY PURPORTED TERMS PRINTED ON ANY DOCUMENTS PREPARED BY PURCHASER IN CONNECTION WITH THE SALE.

The warranty shall not apply to, and Seller shall bear no responsibility for, any product:

1) that has been subject to accident, negligence or misuse, including the effects of transient voltage or attempts to operate the product above rated capacity;
2) that has not been properly installed; or
3) that has been the subject of repairs or modifications accomplished by other than the Seller's factory representative.

This warranty shall extend for a period of twenty-four (24) months from date of shipment for pad-mounted switchgear and twelve (12) years from shipment for stock low voltage transformers. For all other products, it shall extend for a twelve (12) month period from the date of shipment. The warranty shall apply to products and parts manufactured or repaired by the Seller. Products which Seller furnishes, but does not manufacture, carry only the warranty of the original manufacturer of such products. Where other manufacturers' or suppliers' products used in Seller's products prove defective, Seller's liability shall exist only to the extent that Seller is able to recover for the defect from such manufacturers or suppliers.

Compliance with Standards and Regulations: The Seller's products, as built, are intended to comply with ANSI and NEMA standards, MSHA regulations, and other Federal laws and regulations as each may apply to the respective product(s). Seller is willing to comply with other local, state and foreign laws, regulations or standards that may be deemed applicable to the respective products, but will only accept this responsibility upon written notification from Purchaser, prior to order acceptance, of the existence and requirements of such laws, regulations, or standards and written acceptance from an authorized official of Seller setting forth the conditions, if any, for such compliance.

Limitation of Liability: Seller's liability for any claim of any kind shall not exceed the purchase price of the product(s) furnished or the purchase price of the portion of such product(s) which gives rise to the claim. In no event shall the Seller be liable for special, indirect, incidental, or consequential damages, including, but not limited to, loss of profits or revenue; loss of use of equipment or any associated equipment; cost of capital; cost of substitute equipment, facilities or services; or lost value added to the product(s) after receipt and acceptance by the customer.
UNDER NO CIRCUMSTANCES SHALL SELLER BEAR RESPONSIBILITY FOR ANY PENALTIES OR LIQUIDATED DAMAGES UNLESS THAT LIABILITY SHALL BE ACCEPTED IN WRITING THAT MAKES SPECIFIC REFERENCE TO THE TRANSACTION CONTEMPLATED, THAT ITEMIZES THE EXTENT OF THE PENALTY OR LIQUIDATED DAMAGES TO BE ACCEPTED, AND THAT IS SIGNED BY AN AUTHORIZED OFFICIAL OF THE SELLER. NOTWITHSTANDING THE EXISTENCE OF SUCH AN AGREEMENT ON LIQUIDATED DAMAGES, THE FORCE MAJEURE PROVISIONS OF THE FOLLOWING PARAGRAPH SHALL APPLY IN ALL EVENTS.

Seller shall have no responsibility for the cost of any repairs performed by persons other than a factory representative or such independent contractors as may be designated in writing in advance by an authorized official of the Seller.

Force Majeure: The Seller shall not be liable for loss, damage, detention and delay resulting from causes beyond its reasonable control or caused by fire, strike or other labor disturbances, civil or military authority, restrictions of any government or department, branch or representation thereof, insurrection or riot, embargoes, wrecks or delays in transportation, or inability to obtain necessary labor or materials due to failure of suppliers to perform or other causes beyond Seller's reasonable control. In the event of the occurrence of such events, extraordinary measures will be undertaken by Seller only upon Purchaser's written request and agreement to bear the extra expense incurred.

Seller reserves the right to furnish suitable substitutes which cannot be obtained for any of the causes set forth above.

Taxes: Prices as quoted are exclusive of all taxes which may relate in any way to the transaction. In addition to any price specified, Purchaser shall pay any present or future sales, use, excise, value added or similar tax applicable to the price, sale or delivery of any products furnished.

Cancellation: An order may only be terminated upon written consent of the Seller and payment of reasonable termination charges.

Pricing and Escalation Policies: Published prices are subject to change without notice. Quoted prices are firm for acceptance within thirty (30) days from the date of quotation, or such longer period as may be specified in the quotation, but may be withdrawn upon notice.

All catalog and quoted pricing shall be in U.S. Dollars.

If delay is requested beyond the normal delivery period, the price quoted shall escalate at the rate of 1-1/2% per month or prorate part of any month for the time of the delay. Orders amounting to less than $100.00 net will be billed at $100.00 PLUS TRANSPORTATION COSTS.

Prices quoted do not include costs of installation, training, start-up service, coordination, or other on-site services. Such items may be included or quoted separately upon request.

Payment/Credit Terms: Terms are net within thirty (30) days from date of invoice unless otherwise specifically agreed in writing. If, in the discretion of the Seller, the financial condition of the Purchaser does not justify the terms of payment specified, the Seller may require other conditions including but not limited to full or partial payment in advance. The product shall remain the personal property of the Seller until full payment is received. A late charge at the rate of one and one-half percent (1-1/2%) per month will be applicable to past due balances. If shipment is delayed by the Purchaser, the invoice shall issue when Seller is prepared to ship. In the event of default, the Purchaser shall be responsible for all collection costs and reasonable attorney's fees incurred by the Seller. If the Purchaser is not a corporation, the Homestead Exemption is hereby waived. Any disputed amount reflected on the invoice must be directed to the attention of: Controller, Electro-Mechanical Corporation, P.O. Box 8200, Bristol, VA 24203-8200. Payment of other than the exact amount invoiced shall not be deemed satisfaction unless authorized in writing by the Controller.

Delivery and Storage: Delivery shall be made F.O.B. point of shipment with freight prepaid and added to invoice unless otherwise specified in the quotation. Shipping dates in the quotation are approximate and are based upon prompt receipt of all necessary information from Purchaser. Any delay in receipt of complete information shall extend the delivery date for a reasonable time based on the condition of the factory.

Risk of loss or damage shall pass to Purchaser at delivery to the carrier. The Seller takes great care in packing its products and shall not be responsible for breakage or damage in transit after having received "in good order" receipts. Seller will, however, give assistance to Purchaser in any effort to secure a satisfactory adjustment of any claim.

Equipment on which manufacture or delivery is delayed due to any cause beyond Seller's control may be placed in storage by Seller for the Purchaser's account. All risk of loss, charges, and expenses in connection therewith shall be borne by purchaser. However, if in Seller's opinion, it is unable to obtain or continue with such storage, Purchaser will, upon notice, provide or arrange for suitable storage facilities and assume directly all costs and risk connected thereto.

Changes In Specifications: Changes or revisions from specifications upon which the quotation is issued shall be charged to and paid by the Purchaser at the Seller's applicable rates. The Seller's time for performance shall be extended to cover any additional design or production time necessitated by changes requested. Purchaser shall hold Seller harmless from any and all claims, liability, and damage arising from any such extension.

Returns: Products may be returned only with Seller's prior written consent. Only upon return, the material will be inspected and maximum possible credit — less allowance for freight, restocking, restoration to first-class condition, non-stock parts and obsolescence — will be allowed. Unauthorized returns shall remain the property of the Purchaser, and Seller shall have no responsibility for any loss or damage thereto.

Only unused transformers as currently manufactured which have been invoiced to the Purchaser within one (1) year prior will be considered for return. For all other products this return consideration period shall be ninety (90) days from invoice.

Seller reserves the right to refuse any material returned for credit if factory conditions warrant the refusal. Material built to order is not subject to return for credit.

Full credit including all transportation charges will be allowed on returns caused through the fault of the Seller.

General: All orders and contracts are subject to acceptance by Seller at its factory.

Seller reserves the right to correct all clerical and stenographical errors or omissions in quotations, acknowledgments, invoices, and other documents of sale.

Catalog-listed weights, dimensions, and other such specifications are approximate, subject to change without notice, and are not guaranteed.

Any controversy arising under this agreement shall be controlled by the law of the State of Virginia and the exclusive forum for the filing of any litigation shall be in the courts of the City of Bristol, Virginia.

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