Federal Pacific Introduces
PAV Vacuum Switchgear

Newest product is designed for seamless integration of vacuum bottle technology into customers' existing systems.

The Type PAV switchgear builds upon Electro-Mechanical Corporation’s (EMC) experience and expertise with vacuum switches and vacuum fault interrupters in the mining world, where products must continue to operate in a rugged, challenging environment. This product offers that same capability for utility and commercial/industrial applications.

The PAV requires no external power or battery source for basic switching operations and offers a CT-powered relay option for fault interruption, with no additional external power required. This technology affords “trip-free” operation and enables the PAV to provide 2,000 mechanical operations, while offering the same footprint, bushing height and cable configuration as conventional, dead-front pad-mounted switchgear.

In addition, the PAV is available with an optional base adapter, which facilitates an easy transition from existing live-front pad-mounted installations to a vacuum solution.

As a result, customers are able to easily integrate vacuum technology into their existing distribution systems, dead-front or live-front, with room to expand the technology and operational features when external power and communications become available.

The Type PAV switchgear provides a convenient alternative option to upgrade from conventional pad-mounted traditional switch-fuse products for customers who need resettable fault interrupter solutions, three-phase protection to prevent “single-phasing” larger loads, and/or require more switching operations than is available with conventional air-break switches.

Fitting a vacuum product into footprint of conventional dead-front pad-mounted switchgear has been a real challenge up to this point, but Federal Pacific is now able to match the footprint of conventional PSE dead-front switchgear. If a customer has already purchased a conventional air-break switch-fuse switchgear products and wants to upgrade to a vacuum interrupter technology, the PAV fits the common existing dead-front pad-mount footprints, and, with the use of a base adapter of live-front pad-mounted switchgear, such as the PSI/II switchgear.
The PAV offers 630 amp three-phase vacuum switches with visible isolation blades, which are lockable. The visible isolation blades are both electrically and mechanically interlocked with vacuum bottles to prevent load switching with the isolation blades. The visible isolation blades provide full voltage and BIL withstand gap when open, regardless of the vacuum bottle contact position.

This PAV design provides a full-voltage disconnect. While products by other manufacturers may depend on both the visible disconnect and the vacuum bottle in series to achieve the full voltage visible isolation, the PAV provides full voltage ratings in both components. The visible isolation blade is designed to provide a suitable location for lockout/tagout operations when the visible isolation blade is in the open position, giving the field crews visible and lockable isolation points which cannot be inadvertently closed by SCADA operation.

The PAV vacuum interrupter switches are rated for 630 amps continuous or switching. When configured as a fault interrupter, these vacuum fault interrupters are able to provide fault interruption up to 12,500 amps (symmetric). The vacuum fault interrupters eliminate the need for fuses on load taps up to 630 amps continuous and provide three-phase load-side fault interruption which eliminates “single-phasing” of three-phase loads.

The Type PAV vacuum interrupters, when used as fault interrupters, consist of two components instead of one, as in the case of a fuse. The vacuum interrupters have contacts that open inside a vacuum bottle for both load-switching and fault interruption. In the vacuum fault interrupter application, relays that respond to over-currents with preset time-current responses are paired with a magnetic latch to trip open the vacuum bottles. These relays can model a range of either slow or fast fuse curves for a variety of trip set points up to 630 amps.

The new Type PAV Pad-Mounted Switchgear with Visible Isolation Vacuum Switches and Fault Interrupters adds vacuum bottle technology to Federal Pacific’s extensive pad-mounted switchgear product line developed for utility, industrial, government, military, higher education, correctional and medical customers.
Low Voltage Compartment

Isolation Blade Viewing Windows

Relay (for Vacuum Fault Interrupters)

Switch Operators

Switch Operator

Manual Trip Lever to Open

Pump to Close Charges Springs to Open

Open and Close "Targets"

Visible Isolation Blade Operating Shaft with Lockout Tagout Point
Model Images of the PAV Modules

Isometric View — Blades Open

View Through Low Voltage Compartment (left) and Cable Compartment (right)
Typical 4-Compartment PAV Configurations

The common dead-front equivalent 4-compartment designs are available, including, but not limited to:

<table>
<thead>
<tr>
<th>PAV</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>4422</td>
<td>2 switched ways and 2 protected ways</td>
</tr>
<tr>
<td>10</td>
<td>4440</td>
<td>4 switched ways and 0 protected ways</td>
</tr>
<tr>
<td>11</td>
<td>4431</td>
<td>3 switched ways and 1 protected way</td>
</tr>
<tr>
<td>12</td>
<td>4413</td>
<td>1 switched way and 3 protected ways</td>
</tr>
</tbody>
</table>

As well as a new configuration enabled by the introduction of vacuum interrupter technology.

<table>
<thead>
<tr>
<th>PAV</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1299</td>
<td>4404</td>
<td>0 switched ways and 4 protected ways</td>
</tr>
</tbody>
</table>

And the standard 2-compartment designs:

<table>
<thead>
<tr>
<th>PAV</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>4210</td>
<td>1 switched way and 0 protected ways</td>
</tr>
<tr>
<td>4</td>
<td>4201</td>
<td>0 switched way and 1 protected way</td>
</tr>
<tr>
<td>5</td>
<td>4211</td>
<td>1 switched way and 1 protected way</td>
</tr>
</tbody>
</table>

In addition, we can configure the PAV with Auto-jet switches instead of the vacuum interrupter switches (for a lower cost option, where conventional levels of switching operations are expected) or fuses for applications where single-phase loads (or reduced cost) are a consideration.

Data Sheets

The following product data sheets, shown on the next 4 pages provide additional information on dimensions and options available.

<table>
<thead>
<tr>
<th>Sheet</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>PAV-9 Design Front View PDS</td>
</tr>
<tr>
<td>2B</td>
<td>PAV-9 Design Side View PDS</td>
</tr>
<tr>
<td>2C</td>
<td>PAV-9 Design with Auto-jet Air-Break Switch PDS</td>
</tr>
<tr>
<td>2D</td>
<td>PAV-9 Design with Power Fuses PDS</td>
</tr>
</tbody>
</table>

Additional PAV Documents

(Also available on-line at https://federalpacific.com/literature/medium-voltage-switchgear-literature/)

PB-11A-550 – Type PAV Pad-Mounted Air-Insulated Vacuum Switchgear with Visible Isolation Vacuum Switches and Fault Interrupters

Type PAV Product Data Sheet October, 2019

SB-11A-550 October 2019 15kV Class Pad-Mounted Vacuum Switch with Visible Isolation (FVS) and Vacuum Fault Interrupter with Visible Isolation (FVI) – Ratings

Specifications must be verified by factory.
Type PAV Switchgear
Front View

Pad-mounted Air-insulated Vacuum Switchgear
Basic 4-Compartment Vacuum Designs
Vacuum Load-Break Switches – Source Side
and Vacuum Fault Interrupters – Load Side

Typical Footprint for 15kV Designs – 75: Wide x 69-3/4” Deep
(does not include overhang for operating and relay cabinets)

Dimensions for the 15kV PAV-9 as shown
(front view)

Existing PAV-9 Design as Shown
Footprint May Vary for Other Configurations
Due to Cable Compartment Requirements

Specifications must be verified by factory.
Type PAV Switchgear
Right Side View

Pad-mounted Air-insulated Vacuum Switchgear
Basic 4-Compartment Vacuum Designs
Vacuum Load-Break Switches – Source Side
and Vacuum Fault Interrupters – Load Side

Typical Footprint for 15kV Designs – 75: Wide x 69-3/4” Deep
(does not include overhang for operating and relay cabinets)

Section View Thru Compartments
1 and 4, Right Side

Dimensions for the 15kV PAV-9 as shown
(right side view)

Existing PAV-9 Design as Shown
Footprint May Vary for Other Configurations
Due to Cable Compartment Requirements

Specifications must be verified by factory.
Type PAV Switchgear
With Auto-jet Air-Break Switches

Pad-mounted Air-insulated Vacuum Switchgear
Basic 4-Compartment Vacuum Designs
Auto-jet Load-Break Switches – Source Side
and Vacuum Fault Interrupters – Load Side

Typical Footprint for 15kV Designs – 75” Wide x 79-3/4” Deep
(does not include overhang for operating and relay cabinets)

Approximate Dimensions for a PAV-9, with Auto-jet Air-Break Switches on the Line (Source) Side. This is the “J00” Switching Option

Additional Designs
Footprint May Vary for Other Configurations
Due to Cable Compartment Requirements

Specifications must be verified by factory.
Type PAV Switchgear
With Power Fuses

Pad-mounted Air-insulated Vacuum Switchgear
Basic 4-Compartment Vacuum Designs
Vacuum Load-Break Switches – Source Side
and Power Fuses – Load Side

Typical Footprint for 15kV Designs – 75" Wide x 79-3/4" Deep
(does not include overhang for operating and relay cabinets)

Approximate Dimensions for a PAV-9 Design with Power Fuses
(SMU-20 / DBU Fusing) Used on the Load Side, the “FP2” Protection Option

Additional Designs
Footprint May Vary for Other Configurations
Due to Cable Compartment Requirements

Specifications must be verified by factory.
TYPE PAV PAD-MOUNTED AIR-INSULATED VACUUM SWITCHGEAR WITH VISIBLE ISOLATION VACUUM SWITCHES AND FAULT INTERRUPTERS – KEY FEATURES

Featuring:

- **Footprint** - Same as conventional 15kV dead-front pad-mounted switchgear.
- **33” Bushing Height** - Same as conventional dead-front pad-mounted switchgear.
- **Cable Configuration** - Same as conventional pad-mounted switchgear.
- **630A Three-Phase Vacuum Switches** - with visible isolation blades, tested to C37.74.
- **Vacuum Fault Interrupters** - Eliminate fuses on the load taps up to 630A continuous, tested to C37.60.
- **No External Power or Battery Sources** are required to manually close (and trip open) switch or fault interrupter positions.
- **"Trip Free" Operation** - Allows the interrupter to trip open immediately if closed into a fault.
- **CT-Powered Relay Option** - Eliminates the need for a UPS or other battery back-up. Other relay and power options are available. Consult factory.
- **Fully Rated, Interlocked, Visible Isolation** - Isolation blades are interlocked with vacuum bottles to prevent load switching with the isolation blades, providing full voltage and BIL withstand gap when open, irrespective of vacuum bottle contact position.
- **Visible Isolation Blades** are lockable.
- **Base Adapters (Optionally Available)** - Provide an easy transition from existing live-front pad-mount installations to a vacuum solution.

Specifications must be verified by factory.
15kV Pad-Mounted Air-Insulated Vacuum Switchgear - Type PAV

General Design Ratings
Voltage (nominal) ......................................... 15kV
Voltage (maximum)  ....................................... 15.5kV
Frequency ................................................ 50 or 60 Hz
BIL ...................................................... 95kV
Bus Rating ............................................... 630 Amps
Bus Type ................................................ Aluminum (Copper Available)
Insulators ................................................ Cycloaliphatic Epoxy

Vacuum Switch (FVS) per C37.74
Continuous .............................................. 630 Amps
Load Switching .......................................... 630 Amps
Short-Time Withstand (3 Seconds)  ..................... 12.5kA Sym.
Peak Withstand .......................................... 32.5kA
Fault Close ............................................... 20kA RMS ASYM
Mechanical Operations (Close-Open) .................... 2,000

Vacuum Fault Interrupter (FVI) per 37.60
Interruping Amps, RMS Symmetrical .................. 12.5kA
Short Circuit Interrupting Amps, RMS Asymmetrical 20kA
Peak Withstand Current, Amps .......................... 32.5kA
Fault Duty Operations (C37.60 Duty Cycle) .......... 116 Operations

<table>
<thead>
<tr>
<th>Test Duty Level</th>
<th>Percent of Operating</th>
<th>Test Value</th>
<th>Number of Unit Operations</th>
</tr>
</thead>
<tbody>
<tr>
<td>T20</td>
<td>15% - 20%</td>
<td>2 kA</td>
<td>44</td>
</tr>
<tr>
<td>T50</td>
<td>45% - 55%</td>
<td>6 kA</td>
<td>56</td>
</tr>
<tr>
<td>T100</td>
<td>90% - 100%</td>
<td>12.5 kA</td>
<td>16</td>
</tr>
<tr>
<td><strong>Total Number of Operations</strong></td>
<td></td>
<td></td>
<td><strong>116</strong></td>
</tr>
</tbody>
</table>

Typical Design
Line-side: Manually operated (open and close) 3-phase 630A vacuum switches (Type FVS), with integral visible isolation blades, providing full 95kV BIL rated isolation.

Load-side: CT powered relayed (standard) and manually operated (open and close) 3-phase 630A vacuum fault interrupters (Type FVI), with integral visible isolation blades providing full 95kV BIL rated isolation.

Power Requirements: No external power or battery is required to open or trip the vacuum bottles. No external power or battery is required to respond to and clear a fault.

“Trip Free” Operation: Allows the interrupter to begin the trip-to-open sequence immediately if closed into a fault.

Load Tap Fuses Eliminated: Vacuum fault interrupters replace fuses on the load taps.


Vacuum Bottle Technology Provides Thousands of Operations: VFI tested to 2000 mechanical operations, per C37.60, but the vacuum bottle poles are rated for up to 30,000 mechanical operations.

Configurations: All standard 15kV 2-compartment and 4-compartment dead-front configurations are available.

Footprint: Matches conventional PSE dead-front switchgear. Base adapters are available for installation on existing live-front pads or foundations.

Approximate Dimensions:
Footprint: 75” W x 69.75” D (15kV PAV-9 configuration)
Height: 44” H (not including base spacer or adapter)
Bushing Height: 33” H (not including base spacer or adapter)
Operator Cabinet Overhang: 17.75” (per cabinet)

Approximate Weight: 2400 pounds (15kV PAV-9 configuration as shown)
15kV CLASS PAD-MOUNTED VACUUM SWITCH WITH VISIBLE ISOLATION (FVS) AND VACUUM FAULT INTERRUPTER WITH VISIBLE ISOLATION (FVI) - RATINGS (Tested Per C37.60 and C37.74)

FVS Vacuum Switch or FVI Fault Interrupter - Ratings

- Maximum Voltage Rating .............................................. 15.5kV
- Impulse Rating (BIL) ................................................... 95kV
- Frequency ............................................................ 50/60 Hz
- Rated Continuous Amps ................................................ 630A
- Rated Short-Time Withstand (3 Seconds, Sym.) ..................... 12,500A
- Rated Peak Withstand ................................................ 32,500A
- Rated Cable Charging Interrupting Current .......................... 10A
- Mechanical Operations (Close-Open) ................................ 2,000(a)

FVS Vacuum Switch - Ratings (per C37.74)

- Rated Load Current Switching ........................................... 630A
- Rated (Fault) Making Current (Asym.) ................................ 20,000A(b)

FVI Vacuum Fault Interrupter - Ratings (per C37.60)

- Amps, RMS Symmetrical ............................................... 12,500A
- Short Circuit Interrupting Amps, RMS, Asymmetrical ............. 20,000A
- Peak Withstand Current, Amps ....................................... 32,500A
- Rated Line Charging Interrupting Current ............................ 2A
- Fault Duty Rating ...................................................... 116 Operations (c)

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<td></td>
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**IEEE Std. C37.60-2012**

Additional Electrical Ratings

- Visible Isolation Disconnect - Impulse (BIL) ...................... 95kV

Notes:

- a) Verified mechanical operations, per C37.60. Ultimate mechanical duty-cycle of vacuum bottles estimated to be in excess of 10,000 operations.
- b) Based on the C37.60 duty-cycle series – T-100 operation (16 operations @ 90% - 100%)
- c) Fault interruptions per duty-cycle, Table 12, C37.60 – 16 @ 90% - 100% (T-100), 56 @ 45% - 55% (T-50), and 44 @ 15% - 20% (T-20)

Specifications must be verified by factory.
Electro-Mechanical Corporation Overview

Federal Pacific is a division of Electro-Mechanical Corporation, a privately held, American-owned company founded in 1958. It is headquartered in Bristol, Virginia (USA) and for more than 60 years has manufactured a wide variety of products used in the generation, transmission, distribution and control of electricity. These products, along with various electrical equipment repair and maintenance services, are used by a diverse mix of Energy (coal, oil and gas), Electric Utility and Industrial customers worldwide.

Electro-Mechanical Corporation has earned a “customer oriented” reputation by keeping its focus on providing the best value to its customers through quality products and services. With six manufacturing companies and two repair and service companies, Electro-Mechanical Corporation has over 650,000 square feet of modern manufacturing facilities, located in Virginia and Mexico.

The Electro-Mechanical Corporation consists of:

**Federal Pacific** - Dry-type transformers from .050 KVA through 10,000 KVA single and three phase, up to 25 kV, 110 kV BIL with UL® approval through 15 kV; Vacuum pressure impregnation and vacuum pressure encapsulation. Medium voltage switchgear including air-insulated live-front, dead-front, SCADA-controlled, automatic transfer, primary metering and wall-mounted pad-mounted and metal-enclosed switchgear. ISO9001:2015 Registered.

**Line Power Manufacturing Corporation** - Custom engineered electrical distribution and control apparatus including low and medium voltage metal-enclosed switchgear, power control centers, motor controls, and substations. Electrical power distribution systems and components used in mining. ISO 9001:2015 Registered.

**MAFESA** - Electro-Mechanical Corporation’s manufacturing facility in Mexico for stock low-voltage transformers.

**Engineered Solutions** - The Engineered Solutions Group specializes in the innovative design and creation of custom medium voltage switchgear for Data Center, Solar Energy and other alternative energy, mission-critical projects worldwide.

**Machinery Components Division** - Manufactures prototype and machined component products.


**Line Power Parts & Rebuild** - Complete electrical equipment remanufacturing and onsite electrical equipment service. The parts service department provides replacement components manufactured by Electrical Group companies as well as commonly used OEM parts.