

Federal Pacific Type PAV Pad-Mounted Vacuum Switchgear



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Federal Pacific's Type PAV (Pad-mounted Air-insulated Vacuum) pad-mounted switchgear, features vacuum fault interrupter and/or vacuum load interrupter switch designs, both of which provide integral and interlocked visible isolation blades.

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.

Due to these unique features, Customers have the forward-looking flexibility to easily integrate basic vacuum technology into their existing distribution systems, dead-front or live-front, with room to enhance the technology and operational features with the addition of external power and communications.

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 often has been a 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.

The PAV design provides a full-voltage visible 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.

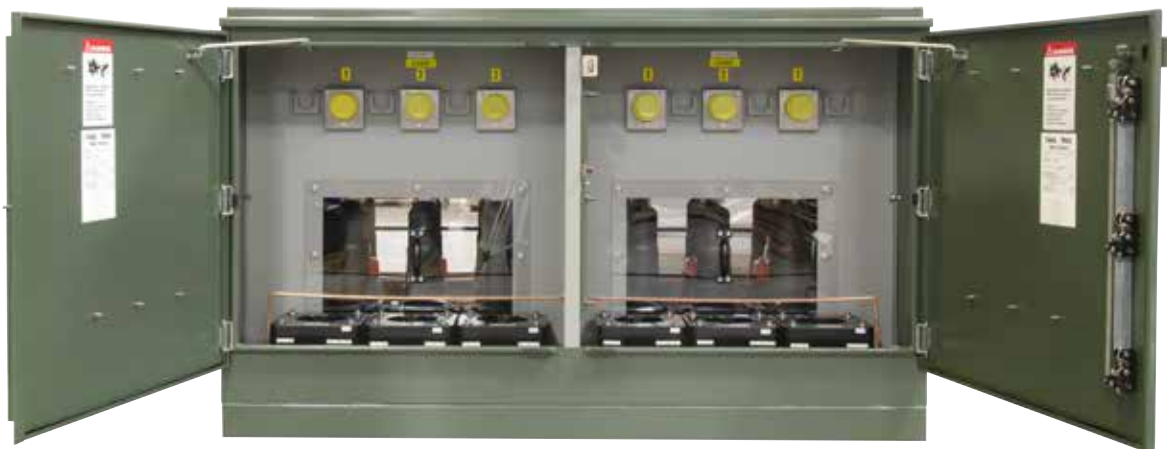
The PAV's three-phase vacuum interrupters have contacts that open inside a vacuum bottle for both load-switching and fault interruption. These vacuum interrupters are rated for 630 amps continuous or switching, whether configured as a vacuum load-interrupter switch or a vacuum fault interrupter.

As a load interrupter switch, the vacuum interrupters have been tested to 2000 load-break operations at their full-load rating of 630 amps, with the vacuum bottles themselves capable of many more operations.

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.

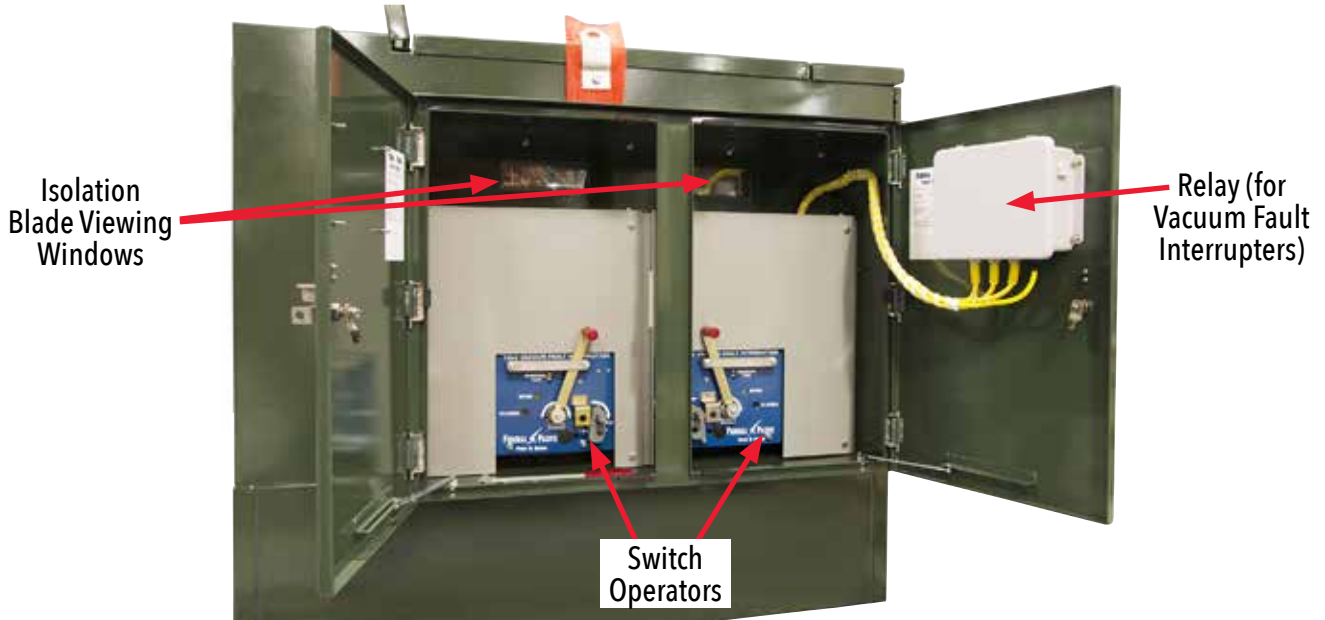
In the vacuum fault interrupter application, relays that respond to over-currents with preset time-current responses to trip open the vacuum bottles. These relays can model a range of either slow or fast fuse curves for a variety of trip set points up to 630 amps.

Federal Pacific's 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.



Type PAV Pad-Mounted Air-Insulated Vacuum Switchgear
with Visible Isolation Vacuum Switches and Fault Interrupters
(Load Side Shown, with 200A bushing wells and Current Transformers)

Low Voltage Compartment



PAV - Mechanical Operators, with FVS Vacuum Switch Operator on the Left Side and the Relayed FVI Vacuum Interrupter Operator on the Right Side

Switch Operator



A Closer View of the Internal PAV Modules



PAV - Vacuum Interrupter with Visible
Break Isolation Closed



PAV - Vacuum Interrupter with Visible
Break Isolation Open

Typical 4-Compartment PAV Configurations

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

PAV-9	4422	2 switched ways and 2 protected ways
PAV10	4440	4 switched ways and 0 protected ways
PAV-11	4431	3 switched ways and 1 protected way
PAV-12	4413	1 switched way and 3 protected ways

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

PAV-94	4404	0 switched ways and 4 protected ways
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And the standard 2-compartment designs:

PAV-3	4210	1 switched way and 0 protected ways
PAV-4	4201	0 switched way and 1 protected way
PAV-5	4211	1 switched way and 1 protected way

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.

2A - PAV-9 Design Front View PDS	Vacuum Switches and Vacuum Fault Interrupters Front View (75" W, 110-11/16" with LV enclosures)
2B - PAV-9 Design Side View PDS	Vacuum Switches and Vacuum Fault Interrupters Side View (75" W, 69-3/4" D - footprint)
2C - PAV-9 Design with Auto-jet Air-Break Switch PDS	Auto-jet Switches and Vacuum Fault Interrupters Side View (75" W, 79-3/4" D - footprint) Note - 10" deeper
2D - PAV-9 Design with Power Fuses PDS	Vacuum Switches and Power Fuses Side View (75" W, 79-3/4" D - footprint) Note - 10" deeper

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

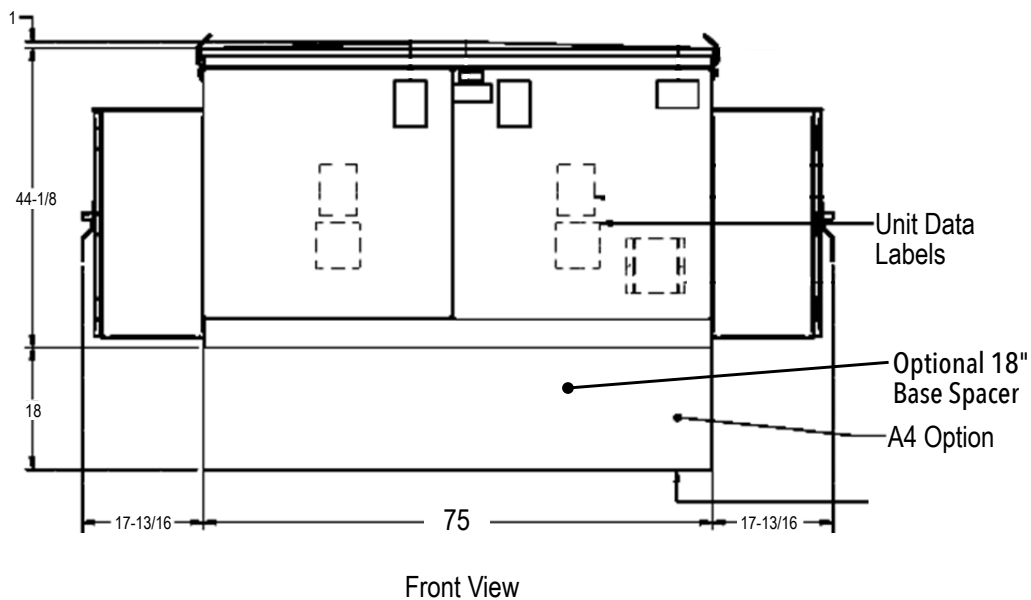
SB-11A-550 October 2019 15kV Class Pad-Mounted Vacuum Switch with Visible Isolation (FVS) and Vacuum Fault Interrupter with Visible Isolation (FVI) – Ratings

Specifications must be verified by factory.

Type PAV Switchgear Front View

Type PAV Switchgear 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)



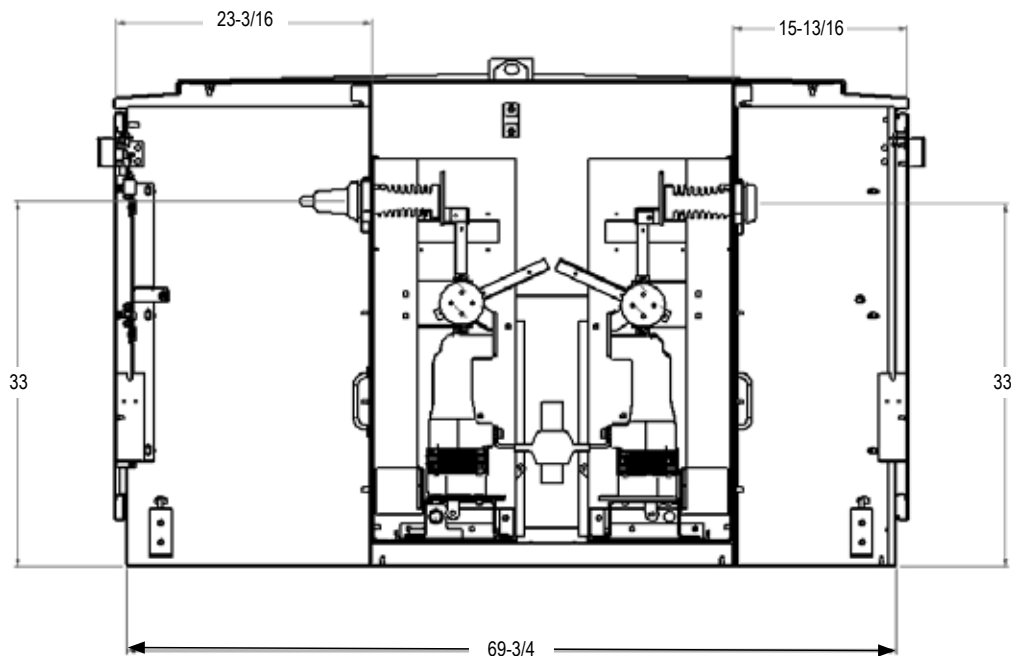
Dimensions for the 15kV PAV-9 as shown
(front view)

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

Type PAV Switchgear Right Side View

Type PAV Switchgear 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

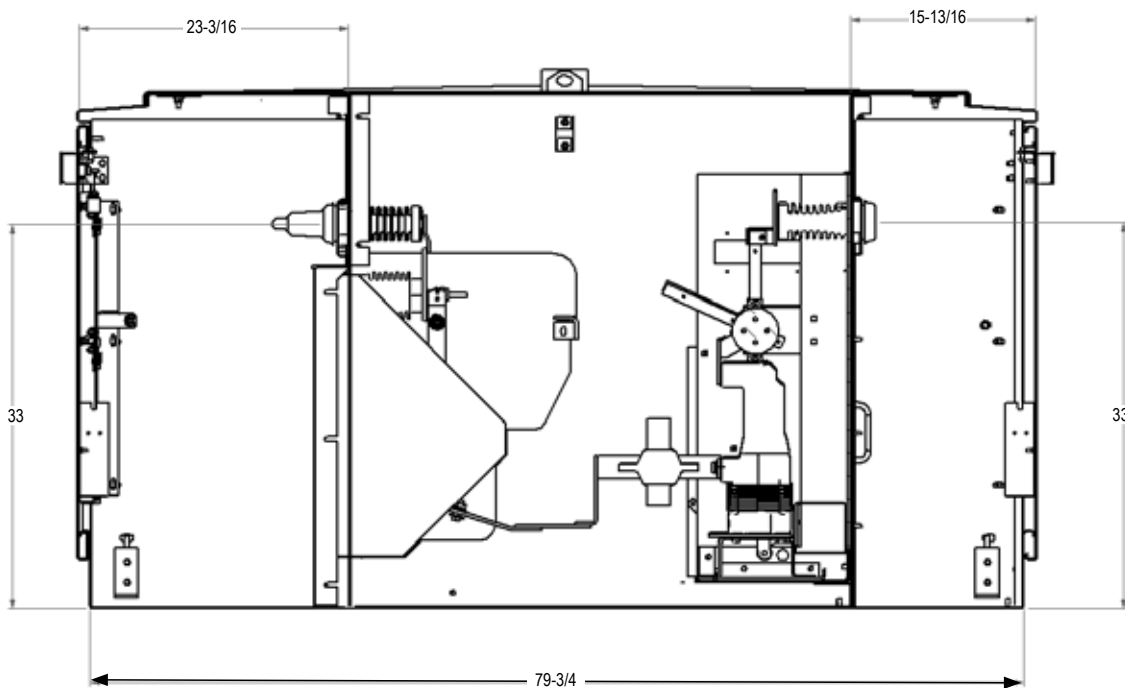
Dimensions for the 15kV PAV-9 as shown
(right side view)

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

**Type PAV Switchgear
With Auto-jet Air-Break Switches**

**Type PAV Switchgear
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)



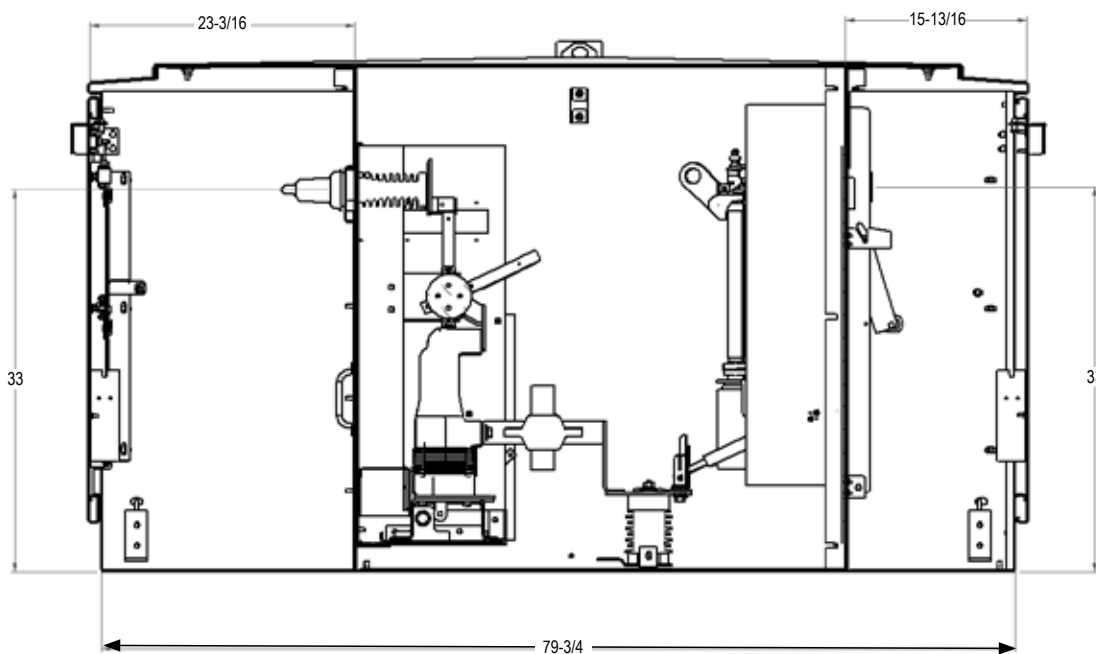
Approximate Dimensions for a PAV-9, with Auto-jet Air-Break
Switches on the Line (Source) Side

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

Type PAV Switchgear With Power Fuses

Type PAV Switchgear 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

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

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.
- Vacuum Bottle Technology - Provides two thousand (2000) mechanical operations.
- 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.
- Three-phase Load-Side Fault Interruption - Eliminates "single-phasing" of three-phase loads.
- 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.



PAV Switchgear - Source (Switch) Side
Shown With Optional Base Spacer



PAV Switchgear - Load (Interrupter) Side
Shown With Optional Base Spacer

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

Interrupting 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

IEEE Std. C37.60-2012			
Table 12 - Performance Characteristics - Standard Operating Duties			
Test Duty Level	Percent of Operating	Test Value	Number of Unit Operations
T20	15% - 20%	2 kA	44
T50	45% - 55%	6 kA	56
T100	90% - 100%	12.5 kA	16
Total Number of Operations			116

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.

Three-Phase Load-Side Fault Interruption - Eliminates "single-phasing" of three-phase loads.

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)

IEEE Std. C37.60-2012			
Table 12 - Performance Characteristics - Standard Operating Duties			
Test Duty Level	Percent of Operating	Test Value	Number of Unit Operations
T20	15% - 20%	2 kA	44
T50	45% - 55%	6 kA	56
T100	90% - 100%	12.5 kA	16
Total Number of Operations			116

Additional Electrical Ratings

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

