



2012 Switchgear Product Enhancements

To remain a viable product offering in any industry, equipment must continue to evolve and bring features that offer enhancements over prior models. Federal Pacific Pad-Mounted Switchgear and Metal-Enclosed Switchgear are no exception. Here, in this December 2012 newsletter, is the compendium of enhancements that have been introduced to these products over the past year. These enhancements demonstrate Federal Pacific's commitment not only to the continued development of switchgear products but also to the electric power industry. Some of these features may have been subject in previous newsletters but are consolidated here and will be an easy-to-find reference in the future.

First in the Industry with 25kV UL Listing

Building upon the successes of the industry's first Underwriters Laboratories, Inc. (UL®) listed 15kV class pad-mounted switchgear (both live-front and dead-front), Federal Pacific has once again raised the bar by

becoming the first (and only) in the industry to obtain UL® listings for 27kV (25kV class) live-front and dead-front pad-mounted switchgear to 25kA symmetrical.

UL® listing for 27kV pad-mounted switchgear follows testing at an independent laboratory that was all witnessed by UL® inspectors, to confirm Federal Pacific's conformance with IEEE/ANSI Standard C37.74, "IEEE Standard Requirements for Subsurface, Vault, and Pad-Mounted Load-Interrupter Switchgear and Fused Load-Interrupter Switchgear for Alternating Current Systems up to 38 kV". In every case, the Federal Pacific switchgear met or exceeded the demanding test series requirements set forth in IEEE/ANSI C37.74. In addition, the testing encompasses compliance with IEEE/ANSI C57.12.28 "IEEE Standard for Pad-Mounted Equipment - Enclosure Integrity."



Figure 1. A major effort by Federal Pacific, demonstrating its commitment to the product and to the industry, has been the attainment of a first-in-the-industry UL® Listing for both 15kV and 25kV pad-mounted switchgear. This means Federal Pacific pad-mounted switchgear has been independently tested to IEEE C37.74 with tests witnessed by an independent third-party certifier, namely, Underwriter's Laboratories Inc.®



Figure 2. In 2012, UL® listings have been added for all of the fuses pictured above (from left Cooper X-Limiter Fuses, Cooper NX fuses in Federal Pacific fuse holder, S&C SML-4Z, Eaton DBU in Federal Pacific end fittings and Cooper X-Limiter in Federal Pacific fuse holder.

Additional UL Listings Achieved in 2012

In addition, Federal Pacific has expanded the UL® listings for the 15kV class pad-mounted switchgear line to include the 25kA RMS symmetrical short-circuit rating, as well as adding UL® listing for most of the additional commonly used fuses at both 15.5kV and 27kV:

Power Fuses: SMU-20 (S&C), SML-4Z (S&C), DBU (Eaton)

Current Limiting Fuses: NX (Cooper), X-Limiter (Cooper)

In addition, the testing utilized Federal Pacific fuse holders in combination with Cooper X-Limiter and NX fuses as well as Federal Pacific end fittings in combination with Eaton DBU fuse units.

WHY is the UL® Listing Important to All Federal Pacific Customers?

- 1) It demonstrates Federal Pacific's commitment to the industry.
- 2) Some accounts may have memory issues with legacy equipment not of Federal Pacific manufacture
- 3) Federal Pacific fully tested both 15kV and 25kV Pad-Mounted units to IEEE C37.74
 - At an independent lab
 - Witnessed by an independent 3rd Party
 - Federal Pacific 15kV and 25kV Pad-Mounted Switchgear all Listed by UL®
 - Covers switches, fuse mountings, bus and fuses of various brands
- 4) This documentation serves to confirm Federal Pacific Pad-Mounted switchgear to satisfy all users

Note: Previous ANSI/IEEE Standards C37.71, C37.72, and C37.73 have been withdrawn and replaced by C37.74-2003.

For complete details on the Federal Pacific UL® Listings, refer to the September 2012 Newsletter.

Single-Sided PSE-9 15kV and 25kV

At the request of a major customer in the Southeast, Federal Pacific developed a "single-sided" access air-insulated dead-front pad-mounted switchgear design in the "9" configuration (two switched source ways and two fused load ways). Designs for service on both a 15kV systems and 25kV systems have been built.

This design places the source switches at each end of the switchgear to allow access to the switch-operating handle, with the fused compartments in the middle, allowing the switchgear to be operated and accessed from three sides, which, in turn, eliminates the requirement for access and

clearance on the "back" side of the switchgear opposite the switch and fuse compartment doors. Thus, the unit can be placed against a wall or other obstruction.

Installation of this single-side design is particularly suitable for locations where there is limited access in a utility easement, such as between a building and a sidewalk. This scenario could easily occur in projects to convert from overhead to underground electrical facilities in areas that have been previously built out and green space is not readily available.



Figure 3. Pictured above are photographs of the single-sided PSI/II-9 unit. This unit will find particular application in locations where a narrow lot line exists, where operating space is limited and where other conditions dictate the advantage of having all cable connections and fuse operation on one side with switch operation not requiring exposure to cables.

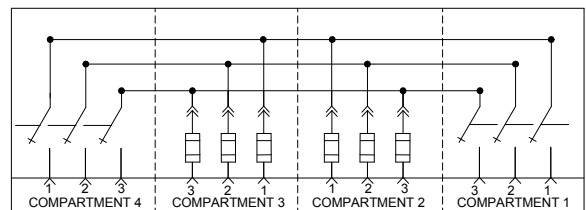


Figure 4. The rear of the unit with the close-off covers removed is pictured above along with a three-line circuit diagram of the single-side PSE-9. Gasket is installed around all four sides of each opening. Tamper-resistant hardware will secure the covers in position and compress the gasket to seal each opening against entry of moisture or contamination. The main interconnecting bus runs along the rear of the unit. The switch-operating handle is shown with the cover removed and the handle in position for operating the switch.

Pad-Mounted Switchgear - Inverter System

When there are multiple voltage requirements for various low-voltage components such as relays and meters, there may be a requirement for an inverter that has increased power capabilities. In addition, the power load requirements of those low-voltage components may be substantial. As a case in point, particular component requirements stipulated in the specification utilized 120vac, 12vdc, 24vdc and 48vdc. The battery backup

was a 48vdc system that could handle all the power requirements, but an inverter was needed to generate the 120vac that could be input to existing components and to provide the necessary other dc voltages. An adequate inverter was identified and integrated into the power supply system.



Figure 5. An inverter capable of utilizing a 48vdc input and with adequate 120vac output to maintain all critical systems for the particular application is illustrated above. The inverter was integrated into the low-voltage compartment (pictured above) and provides the necessary power output in the event the normal 120vac control-power source is lost. It remains necessary to keep all relays associated with the protection system energized and ready to initiate appropriate switching functions at all times in the event a fault occurs as well as to provide alarm when other system disturbances or conditions warrant.

Pad-Mounted Switchgear - Automatic Transfer with Auto-jet® II - Protection with VCB

For critical loads, service continuity is an essential reliability requirement that is best achieved economically with automatic-transfer switchgear. For smaller systems, automatic-transfer pad-mounted switchgear becomes the most economical choice. Integrated with vacuum

fault interrupters on the load circuits, the unit also (1) provides fast response to faults on the downstream cables and transformer circuits and (2) allows frequent repetitive switching on the load circuits using the vacuum interrupters.

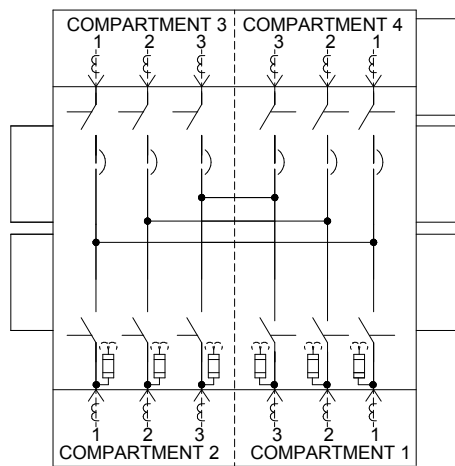


Figure 6. The Dead-Front Automatic-Transfer ATPVE-9 pictured and diagramed above provides primary-selective service to critical loads at the user's installation utilizing Federal Pacific Auto-jet®II Load Interrupter switches. Switching and protection of the load circuits is provided by relayed vacuum circuit breakers with visible disconnects.

The Federal Pacific Dead-Front Automatic-Transfer ATPVE-9 illustrated above insures load-service continuity to critical loads at the customer's installation. The incoming supply cables can be from two (2) utility sources or a utility source and a standby generator. In either case, the loss of the normal utility source will initiate transfer to the alternate source whether it is a utility source or a generator. Such configurations offer contingency arrangements that will provide the essential backup power supply in the event any of the most frequent types of power outages occur.

A standby generator, whether it be the alternate supply source or as a backup for two utility sources, makes for a very reliable system. However, in the latter case, the standby generator is not typically sized (due at least in part to economic considerations) to carry the entire load and that some load shedding may be necessary before the transfer is initiated. If the load shedding is not automated, the process may result in longer outage times before service is restored. In all cases where generators are involved, the synchronization in going from utility source to a generator is always a function that is performed by the generator controls and not by the controls in the pad-mounted switchgear.

Portable Remote Operator - for Manual Pad-Mounted Switchgear



Figure 7. Federal Pacific's Portable Remote Operating Mechanism is transported on a two-wheel cart to the unit. The support bracket is mounted in the existing switch-operating handle pocket without requiring any modification of the enclosure and without requiring any tools. The air cylinder is mounted on the support bracket; the air hose is connected to the air cylinder and the CO₂ tank, which is moved away from the unit and the tank opened with the gas pressure released by turning a valve opening/closing the switch.

Federal Pacific has continued to expand its line of Portable Remote Operating Mechanism (PROM) offerings with a version designed for application on Federal Pacific manual Live-Front (PSI/II) and Dead-Front (PSE) pad-mounted switchgear. The PROM-PM allows manual Federal Pacific pad-mounted switchgear to be operated at distances of up to 50 feet from the switchgear. The mechanism can be quickly installed, operated, and removed from the switchgear without the need for disconnecting any existing component, without requiring the use of any tools, and without requiring any drilling or other modifications that might affect the integrity and security of the switchgear.

Remote operation allows switching by personnel to be performed outside of the arc-flash boundary zone. Perhaps even more importantly, this new tool allows field personnel to affect and regulate the one key variable under their control – distance from a potential arc event, rather than relying on others to perform mitigating functions (controlling the intensity or duration of the potential arc) at an unknown and unseen location or having to wear uncomfortable and restrictive PPE flash suits.

Some of the major features and benefits of the PROM-PM:

- Portable tool that allows operation of Federal Pacific pad-mounted equipment outside of the arc-flash zone (up to 50 feet from the switchgear).

- The PROM-PM will fit nearly all standard Federal Pacific PSI/II Live-Front or PSE Dead-Front manual pad-mounted switchgear

- The PROM-PM requires no drilling to install or remove

- No modification of the cabinet is required

- Simple one-person installation, operation, and removal

- Pneumatic operation requires no external power supply – no cords or batteries

- Operating station and carrier provides portability and storage of the PROM-PM and its CO₂ tank

All Stainless-Steel Switch

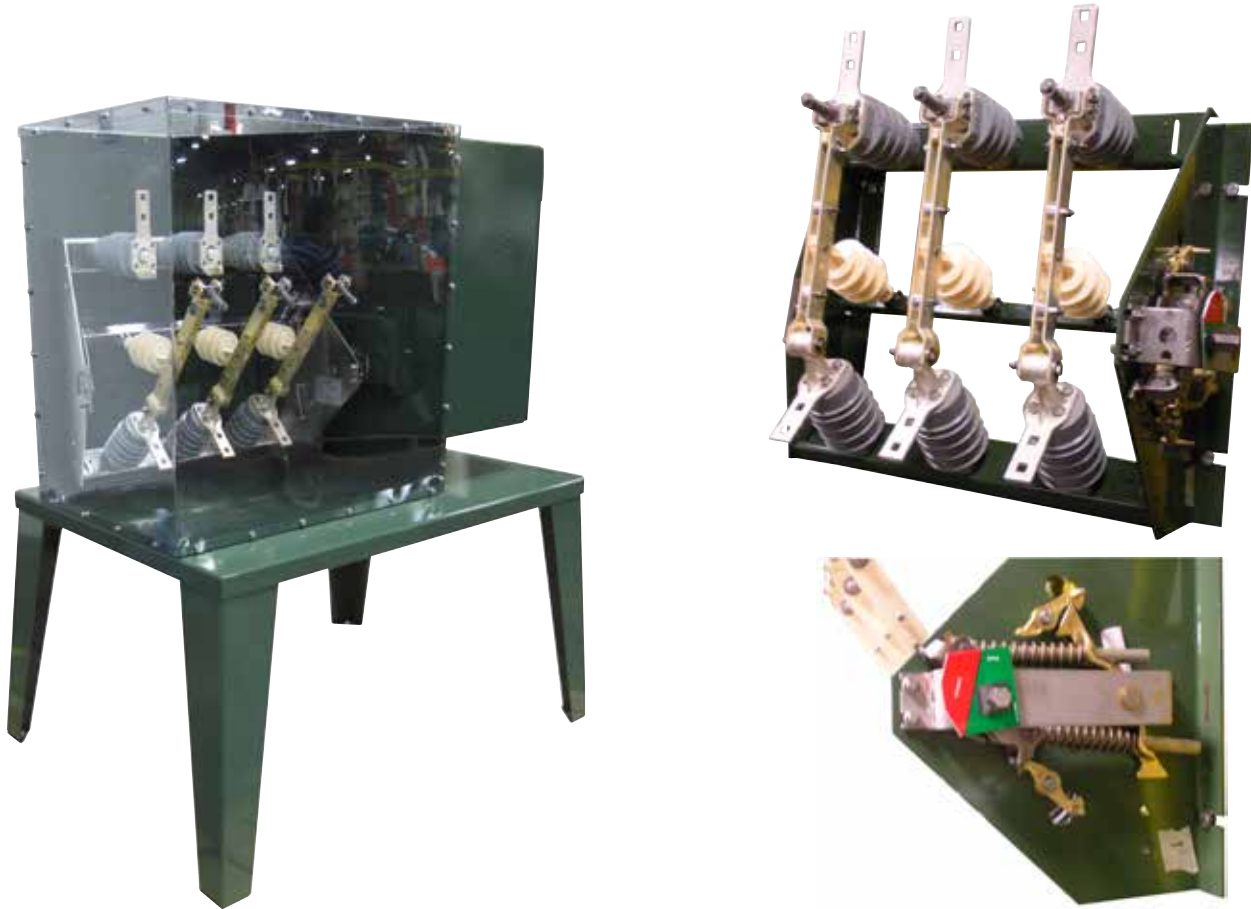


Figure 8. Federal Pacific's all stainless-steel switch is especially suited for application in salt-laden environments such as found in coastal areas around the United States, in the Caribbean and in South America. At left the stainless-steel switch is motor operated demonstrating its suitability for manual or automated application. At the top right, the stainless-steel switch frame is painted green. The bottom photo at right shows the stainless-steel mechanism (note that some parts are of non-ferrous materials).

This variant of the Auto-jet®II switch was developed for coastal and other applications with harsh corrosive environments. All of the mild steel components have been replaced with stainless steel or other inherently non-corrosive materials. Current-carrying components remain copper.

Among the key components for conversion to stainless steel were the springs used to drive the opening and

closing of the switch. Since the material properties or elasticity vary greatly from common spring steel to stainless steel, this was not a trivial issue. After much research and testing, a suitable stainless steel spring was implemented.

After further analysis, it was determined that the stainless steel spring design would be replicated across the board for 15kV Auto-jet®II switches.

Stainless-Steel Spring on 15kV Switches

The development of the all stainless-steel 15kV Auto-jet switch required, among other things, a thorough evaluation of the stainless-steel spring as an alternate to the standard spring that is part of the switch-operating mechanism. This operating spring, of which there are two on each switch, supplies the energy necessary to rotate the operating arm to either push the switch blades open or pull the switch blades closed. The speed of operation in opening/closing the switch is the critical factor in determining successful switching operations because it determines the arcing time. The longer the arcing time, the greater the wear on interrupting contacts.

Following exhaustive testing to prove both the durability as well as the speed of operation, the stainless-steel spring was proven to be equal or superior in performance to the previous standard spring. In addition, the stainless-steel spring has superior performance to the standard spring in salt-spray testing. With proven superior durability and performance characteristics, the stainless-steel spring has been accepted as the new standard spring on all 15kV Auto-jet®II load-interrupter switches.

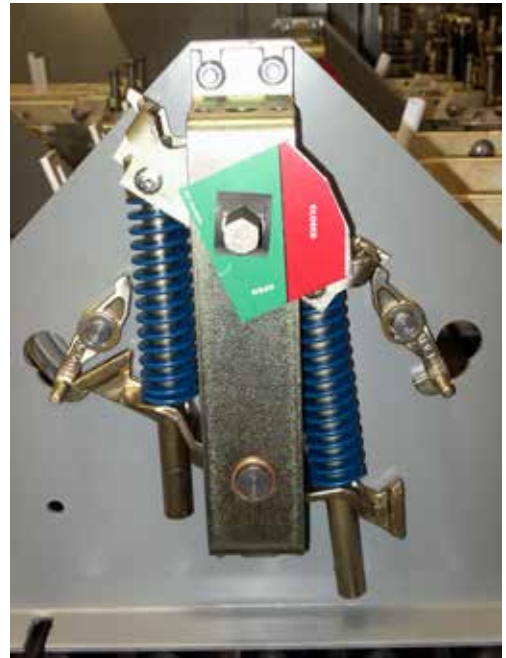


Figure 9. Switch-operating mechanisms of Federal Pacific 15kV Auto-jet®II load-interrupter switches now incorporate stainless-steel springs. These high-performance springs offer significant enhancement over the springs previously used especially in resistance to corrosion as proven in salt-spray testing as well as in mechanical performance as proven by exhaustive mechanical testing, including timing tests. The top photo shows the two springs with the solid blue spring being the old-style spring. The stainless spring has only a partial blue overspray applied for differentiation from other springs in the factory. The stainless steel springs are shown installed on a switch in photo at bottom left and the old style are shown on the switch at bottom right.

Enhanced Turnbuckle - Cutover December 2012

In late December 2012, Federal Pacific implemented a new style of turnbuckle (also known as a "push a rope"), which is used to connect each fuse panel on PSE dead-front pad-mounted switchgear to its respective associated shutter barriers. The turnbuckle functions to operate the red GPO-3 fiberglass shutter barrier

(1) pulling the shutter barrier to close off the fuse-panel opening in the equipment mounting wall when the fuse is accessed and (2) pushing the shutter barrier into the interior of the high-voltage compartment when the fuse panel is closed.

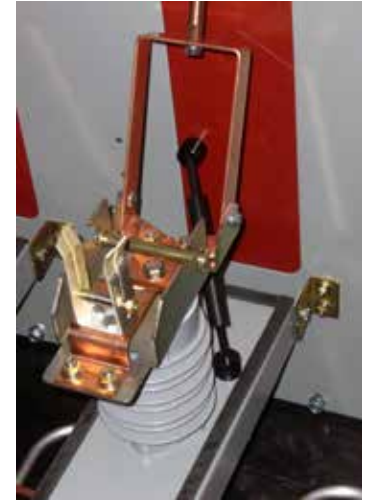


Figure 10. Federal Pacific has developed a new turnbuckle, which is connected between the fuse panel and the red GPO-3 fiberglass shutter barrier. The enhanced design (in black) has increased mechanical capability and is easier to install, remove and replace. It can be used to replace installed earlier-design turnbuckles, requiring only the addition of a suitably-sized hole in the barrier.

The new enhanced black turnbuckles provide a simpler and more robust design than the white turnbuckles previously used. Although the color change was not required from a material viewpoint, as the material remains the same, it was determined that a color change would more clearly differentiate the new style of turnbuckle from the older design. Look for these new black turnbuckles in the upcoming unit shipments into your respective sales territories.

The durability of the turnbuckle was confirmed through exhaustive mechanical testing. In the test, the new turnbuckle was installed as it would be applied on a fuse panel. A pneumatic operator was connected to the latch on the fuse panel, which was then cycled over 10,000 open/close operations. The turnbuckle survived without any evidence of deterioration or fracture.

If the need arises, the new turnbuckle can be used to replace an installed turnbuckle of the old style. In such cases, a hole of suitable size needs to be drilled in the fiberglass barrier to accommodate the threaded-bolt end of the new turnbuckle. With the hole drilled, it makes the installation of a black turnbuckle as a replacement for an old-style white turnbuckle much easier than if an old-style turnbuckle is used as the replacement. The old-style turnbuckle required installation of several small screws and these screws were not only difficult to position into the hole, but they are also difficult to tighten into place in the hole.

Summary of Recent Changes to the Metal-Enclosed Switchgear Product Line.

1) Arc-Flash Avoidance.

Motor Operated Federal Pacific Metal-Enclosed Switchgear permits remote operation of critical primary loads (such as transformers) while reducing the exposure of operating personnel by allowing them to operate the switchgear from a position outside of the arc-flash zone of the switchgear and away from oil-filled transformers and other loads.

Three options for remote operation are available:

- Remote operation from a control room by means of a hard-wired installation, fiber optics, cellular, or radio control.
- Local electrical operation, connecting to the motor operator through a 50-foot cable connection and actuating the switch through a hand-held control station using open/close pushbuttons. This option is illustrated below.
- By means of a relay action responding to an overcurrent condition when the fuse operates.
 - a) Hand-held control station with open/close pushbuttons on a galvanized-steel box
 - b) 50 –foot cable
 - c) External cable connector on left side, bottom front
 - d) Internal wiring to connect to the open/close contacts on the motor-operator terminal block.



Figure 11. Metal-enclosed switchgear and pad-mounted switchgear (not pictured) equipped with motor operators can be supplied with a remote-control station to allow operation from a distance of up to 50 feet.

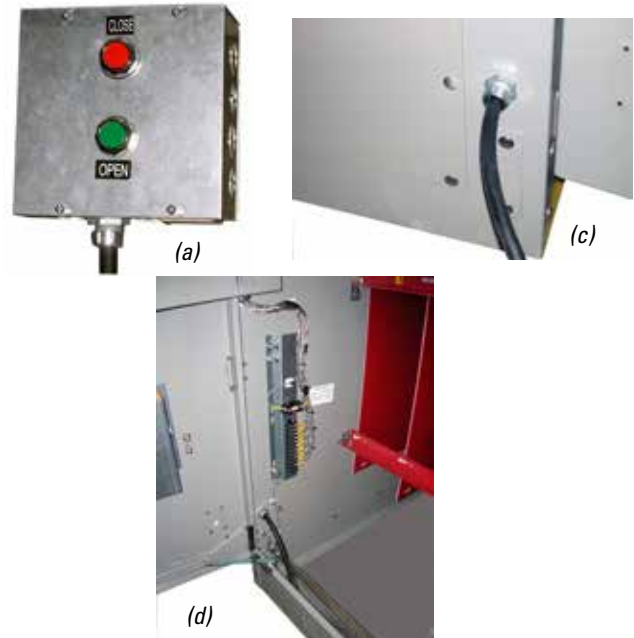


Figure 12. The hand-held control station includes open/close pushbuttons mounted on a galvanized-steel box (a) with a 50-foot cable. See (b) on Figure 14. The cable connects to the interior of the switchgear assembly through a connector on the left side (c) at the bottom front and is wired (d) to the open/close contact terminals on the motor-operator terminal block.

A 1.0kVA Uninterruptable Power Supply (UPS) is provided to allow remote operation in the event that control power is lost. The unit includes a wide LCD display and can be provided with an optional network interface card and an optional environmental monitoring device.



Figure 13. UPS tower-mount design installs in the enclosure stile above motor operator and extends into interior supported by a steel tray and secured by brackets. The 1.0kVA UPS unit is able to supply uninterruptable, single-phase power adequate to operate the motor operator for an extended period of up to 7 minutes at full load after control power has been lost. The unit includes a wide LCD display and also features programmable load-shed receptacles and can be provided with an optional network interface card and an optional environmental monitoring device.

2) Federal Pacific Integrates Vacuum Switch and Controls into Metal-Enclosed Switchgear for Frequent Switching Application

When customers have particularly demanding loads, Federal Pacific can provide solutions tailored to meet the customer's needs.

Federal Pacific Metal-Enclosed Switchgear in a four-bay design demonstrates the willingness, capability and expertise to develop sophisticated circuits providing unique features for application specific project requirements. The lineup is configured with two incoming shunt-trip load-break switch bays (on the left in Figure 17) for primary-selective service and visible isolation on the source side, the vacuum switch in the third bay, and the current-limiting fuses for load protection and shunt-trip load-break switch (providing visible isolation on the load side) in the fourth bay (far right).

Customer Requirements:

- Primary Selective Service
 - Auto-jet®II switches
- Long-life frequent load-switching
 - Vacuum switches
- Provide protection against single-phasing on source and load
 - Shunt-trip on all Auto-jet®II switches
- Provide over-current protection for load
 - Current Limiting fuses
- Provide real-time incoming voltage and current measurement
 - CTs and VTs on each phase, analog voltmeters and ammeters
- Provide real-time load voltage and current measurement
 - Rockwell PM3000 for real-time power load-side quality data.
- Provide secure sequential switching scheme.
 - Mechanical interlocks on the doors and key interlocks on the source feeds

The Joslyn 15kV 600 amp VBT vacuum interrupter in Bay 3 was selected due to its ability to load-switch over 100 times per day, and its 100,000 operations rated switching life.

For comparison, load-interrupter switches are required to break load of various types only 100 times or less in typical industry standards, such as C37.74.

The Rockwell-3000 digital power monitor mounted on the door of Bay 4 (shown at bottom right) provides real-time power quality data, harmonics analysis, high-speed oscillography, and sub-metering.

The CTs and PTs that provide input to the power monitor are located in adjacent Bay 3.



Figure 14. Federal Pacific Metal-Enclosed Switchgear in a four (4) bay configuration features (from left) two incoming switch-only bays for primary-selective service (and also serve as the line-side visible disconnect for the vacuum switch), a bay containing a vacuum switch and a switch/fuse feeder bay that provides circuit protection for the load circuit as well as providing a load-side visible disconnect for isolating the vacuum switch when maintenance service is required. The one-line diagram is below.

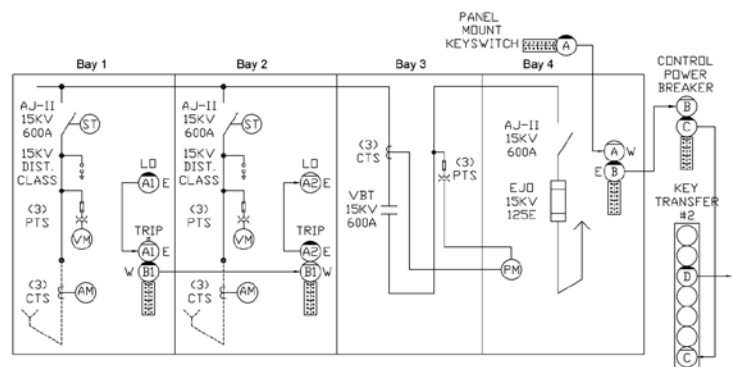


Figure 15. Pictured above is Bay 3, which includes the VBT vacuum interrupter switch for frequent sustained switching of the load circuit.



Figure 16. The digital power monitoring meter that allows real-time display of the various circuit parameters is mounted on a hinged, bolted panel in a low-voltage compartment that is isolated from high voltage.

3) U-Shaped Metal-Enclosed Switchgear Assembly Illustrates Design Flexibility That Produces Orders

19-bay Federal Pacific Metal-Enclosed Switchgear in a U-shaped configuration is pictured nearing completion. Open bays – incoming termination compartment on each end and bus-transition sections on interior units will be closed off with cover plates.

A customer needed an extensive line-up of 5kV switchgear with a minimum footprint for a vault application inside a building. Federal Pacific responded to this need with a U-shaped switchgear design to meet the customer’s requirements.

Significant Features:

- a) Bays arranged in compact “U” configuration to meet space limitations.
- b) Provides high-current ratings and essential switching and protection requirements.
- c) Connected in main-tie-main configuration, allowing half of lineup to be capable of supplying critical loads if one source is lost.

Extending across the entire rear of the switchgear assembly are full-height sheets of GPO-3 grade fiberglass. These insulating sheets, attached with non-metallic hardware, provide insulation of the metal switchgear surfaces from adjacent energized components that are located in the vault where the equipment will be installed.



Figure 17. A 19-bay switchgear assembly configured in a U-shaped arrangement is pictured above nearing completion. Open bays, which are incoming-termination compartments on each end and bus-transition sections on interior units, are closed off with cover plates. This indoor assembly matches to available room size at the installation and minimizes expense associated with capturing floor space from rental or production area for utility services at any facility.



Figure 18. Extending across the entire rear of the switchgear assembly are full-height sheets of GPO-3 grade red fiberglass. These insulating sheets, installed with non-metallic hardware, provide isolation of the metal switchgear surfaces from adjacent energized components that are located in the vault where the equipment will be installed.

4) Provisions for PROM Standard on Federal Pacific Metal-Enclosed Switchgear Provides Ability to Mitigate Exposure to Arc-Flash Hazards

Federal Pacific Metal-Enclosed Switchgear now includes provisions to accommodate PROM, which makes it possible to operate manual switches from a location up to 50 feet away. The provisions can also be retrofitted on installed units of Federal Pacific Metal-Enclosed Switchgear bays that include manually operated Auto-jet®II load-interrupter switches. PROM is Federal Pacific's line of CO₂ actuated Portable Remote Operating Mechanisms that can be purchased separately. The PROM units are available for application on Federal Pacific Metal-Enclosed and Pad-Mounted Switchgear rated through 38kV.



Figure 19. Portable remote operating mechanism available from Federal Pacific can be mounted over switch-operating handle on switchgear stile and operated from a distance of up to 50 feet to open and close the switch using compressed air or CO₂. Similar arrangements are available for pad-mounted switchgear.

For Federal Pacific Metal-Enclosed Switchgear, already equipped with the mounting provisions, installation is a direct application of the PROM. Simply (1) install and secure the air cylinder over the manual operating handle, (2) connect the 50-foot of hose, which has quick-release connectors at each end, to the air cylinder and the CO₂ tank, (3) roll the CO₂ (extending the hose) to an adjacent location and (4) open the valve to release the compressed air. On release of the compressed air, the switch operates immediately and can be opened or closed.

Personnel no longer have to stand in front of the switchgear when opening and closing switches. Personnel are outside the arc-flash boundary so there is little exposure to an arc-flash hazard and the PPE required is minimized.



Figure 20. Metal-enclosed switchgear (and pad-mounted Switchgear not pictured) is shown equipped with a Federal Pacific Portable Remote Operating Mechanism on the bay at right to allow operation from a distance of up to 50 feet using compressed air or CO₂.

From the foregoing extensive list of enhancements introduced by Federal Pacific in 2012, it is clear that Electro-Mechanical Corporation's vision remains focused on its customers and its core value of remaining committed to serving its customers have been well served. All of the new product enhancements, product extensions and new products are evidence to our customers not only of that commitment but the continued commitment to research and development further demonstrates that Federal Pacific pad-mounted and metal-enclosed switchgear are the best in the market. Make sure customers are informed of all of these 2012 product enhancements and developments.

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