Federal Pacific Switchgear Products
5kV through 38kV
Manual - Automated Distribution - Smart Systems
2, 4, 6 or 8 Compartments
Live-Front Pad-Mounted Switchgear
Live-Front/Dead-Front Pad-Mounted Switchgear
Dead-Front Pad-Mounted Switchgear
Vacuum Interrupter Pad-Mounted Switchgear
Primary Metering Switchgear
Pad-Mounted Capacitor Banks
Fused Sectionalizer Dead-Front Switchgear
Metal-Enclosed Switchgear
Wall-Mounted Cabinets
Unit Substations
Portable Substations
Reclosing Vacuum Fault Interrupters
Network Protectors
Custom-Engineered Products
Components

Federal Pacific Dry-Type Transformer Products
120v through 34.5kV, 10kV - 150kV BIL
25va through 10MVA
Single-Phase and Three-Phase
Industrial Control Transformers
Type FB Encapsulated General Purpose and Buck-Boost Transformers
Type FH Ventilated Transformers
High Voltage General Purpose
Pad-Mounted Transformers Per C57.12.28
Unit Substation and High Voltage Power Transformers
Vacuum Pressure Impregnated (VPI) and VPI/Epoxy Shielded
Specialty Transformers
NEMA TP-1, NEMA Premium, and DOE 2010 Efficiencies Transformers
Metal-Enclosed Load-Interrupter Switchgear

Description: Three-Phase, Group-Operated Load-Interrupter Switches with Fuses in Single and Multi-Bay Assemblies

Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip

Circuit Configurations: Per Specification

Applicable Standards: C37.20.3, C37.20.4, C37.57, C37.58 and C57.12.28

UL® Listing at 5kV and 15kV, 600 to 1200 amperes

Voltage Range: 5kV — 35kV

BIL: 60kV — 200kV

Ratings:
- 600 and 1200 ampere continuous 3-phase load-break switches
- Fusing to 1100 amps with current-limiting fuses
- Fusing to 720 amps with power fuses

Switch 3-Phase
- 40ka asymmetrical 3-time fault-closing
- 61ka asymmetrical 1-time fault-closing
- 61ka momentary at 38kV
- 100 load-break operations at 600 amperes

UL® Recognized — 600A, 1200A at 5kV and 15kV

1,000 mechanical operations

Optional Features:
- Key Interlocks
- Stainless Steel Enclosure
- Copper Bus
- Special Colors
- Metering Requirements
- Monitoring Requirements
- Vacuum Circuit Breakers
- Category A, B and C Enclosures
- Close-Coupled to Transformer
- Stainless Steel Switches

Users:
- Utility, Industrial, Military, Universities, Correctional, Hospitals, WWT Facilities

Unit Substation Primary Switchgear

Description: Three-Phase, Group-Operated Load-Interrupter Switches with Fuses in Single and Multi-Bay Assemblies in Combination with Dry-Type Transformers

Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip

Circuit Configurations: Per Specification

Applicable Standards: C37.20.3, C37.20.4, C37.57, C37.58 and C57.12.28

UL® Listing at 5kV and 15kV, 600 to 1200 amperes, 1,000 mechanical operations

Voltage Range: 5kV — 35kV

BIL: 60kV — 200kV

Transformers: Through 10MVA at 35kV to C57.12.51

Current Ratings:
- 600 and 1200 ampere continuous 3-phase load-break switches
- Fusing to 1100 amps with current-limiting fuses
- Fusing to 720 amps with power fuses

Switch 3-Phase
- 40ka asymmetrical 3-time fault-closing
- 61ka asymmetrical 1-time fault-closing
- 61ka momentary at 38kV
- 100 load-break operations at 600 amperes

UL® Recognized — 600A, 1200A, 5kV, 15kV

1,000 mechanical operations

Optional Features:
- Key Interlocks
- Stainless Steel Enclosures
- Copper Bus
- Special Colors
- Copper Core & Coil
- Stainless Steel Switches
- Metering Requirements
- Monitoring Requirements
- Vacuum Circuit Breakers
- Category A, B and C Enclosures

Users:
- Utility, Industrial, Military, Universities, Correctional, Hospitals, WWT Facilities
Air-Insulated Live-Front Pad-Mounted Switchgear — Type PSI/II

Description: Three-Phase, Group-Operated Load-Interrupter Switches and Single-Pole, Hookstick Operated Fuses with Integral Load-Interrupters for Switching

Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip

Circuit Configurations: 25 one-line diagrams in 2, 4, 6 and 8 compartment designs

Applicable Standards: C37.74 and C57.12.28

Voltage Range: 15kV - 25kV (for 38kV consult factory)

Current Ratings:
- 600 and 1200 ampere continuous 3-phase load-break switches
- 200 ampere continuous 1-phase load-break with fuses
- Fusing to 200 amperes with current-limiting or power fuses

Switch 3-Phase
- 40ka asymmetrical 3-time fault-closing
- 61ka asymmetrical 1-time fault-closing
- 100 load-break operations at 600 amperes
- UL® Listed — available to 600A at 15kV and 25kV
- 1000 mechanical operations

Optional Features:
- Key Interlocks
- Base Spacers
- Stainless Steel Enclosure
- Stainless Steel Switches
- Cable Supports
- Colors
- Provisions for Fault Indicators
- Metering Transformers
- Designs Engineered to Customer Requirements

Users: Utility, Industrial, Military, Universities, Correctional, Hospitals, WWT Facilities

Air-Insulated Dead-Front Pad-Mounted Switchgear — Type PSE

Description: Three-Phase, Group-Operated Load-Interrupter Switches with Single-Pole, Hookstick Operated Fuses with Bushing Wells for 200-Ampere Load-Break Elbows

Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip

Circuit Configurations: 20 one-line diagrams in 2, 4 and 6 compartment designs

Applicable Standards: C37.74, C57.12.28 and ANSI 386

Voltage Range: 15kV — 25kV (for 38kV, consult factory)

Current Ratings:
- 600 ampere continuous 3-phase load-break switches
- 200 ampere continuous 1-phase load-break elbows
- Fusing to 200 amperes with current-limiting or power fuses

Switch 3-Phase
- 40ka asymmetrical 3-time fault-closing
- 100 load-break operations at 600 amperes
- UL® Listed — available to 600A at 15kV and 25kV
- 1000 mechanical operations

Optional Features:
- Key Interlocks
- Base Spacers
- Stainless Steel Enclosure
- Copper Bus
- Stainless Steel Switches
- Fuse Storage
- Cable Supports
- Special Colors
- Provisions for Fault Indicators
- Metering Transformers
- Designs engineered to customer requirements

Users: Utility, Industrial, Military, Universities, Correctional, Hospitals, WWT Facilities
Air-Insulated Dead-Front Vacuum Interrupter Pad-Mounted Switchgear – Type PVE

Description: Three-Phase, Group-Operated Vacuum Interrupter and Three-Phase Group-Operated Vacuum Fault Interrupters.


Circuit Configurations: Multiple switching and protection arrangements in 2, 4 and 5 compartment designs.

Applicable Standards: C37.74, C57.12.28, C37.60, ANSI/IEEE-386

Voltage Range: 15kV and 25kV

Current Ratings: 600 amp continuous 3-phase load-break vacuum interrupters, with 1200 amp available at 15kV

Three-time fault closing rating of 12,500 amps symmetrical / 20,000 amps asymmetrical.

Rated for up to 10,000 load break operations at rated current.

600 amp continuous 3-phase vacuum fault interrupters, with 1200 amps available at 15kV

Interrupting and fault close rating of up to 18,000 amps symmetrical / 28,800 amps asymmetrical at 15kV

Interrupting and fault close rating of 12,500 amps symmetrical / 20,000 amps asymmetrical at 25kV.

Compliant with fault interrupting duty specified in C37.60.

Standard Features: Visible Disconnect on each Vacuum Interrupter

Vacuum Interrupters – 200 amp and 600 amp

Resettable Vacuum Fault Interrupters – 200 amp and 600 amp

Overcurrent Protection with Self-Powered Relay or SEL 501-2 Relay, on Vacuum Fault Interrupters

Three-Phase Switching and Fault Protection

Two-Way and Multi-Way Configurations

External Manual or Motor Operators

200 Amp Bushing Wells

600 Amp Bushings

Insulated Main Bus

11 Gauge Welded Steel Enclosure

Optional Features: 1200 amp rating available at 15kV.

Motor operators for SCADA or automatic transfer.

Provisions for Fault Indicators

Stainless Steel Key Interlocks

Base Spacers Copper Bus

Special Colors 200 Amp Bushing Wells

Typical Users: Utilities, Industrial, Military, Universities, Correctional Hospitals, Water Plants
SWITCHGEAR DIVISION PRODUCT PROFILES

Air-Insulated Live-Front / Dead-Front Pad-Mounted Switchgear — Type PLD

Description: Three-Phase, Group-Operated Load-Interrupter Switches and Single-Pole, Hookstick Operated Fuses with Bushing Wells for 200-Ampere Load-Break Elbows

Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip

Circuit Configurations: A variety of one-line diagrams

Applicable Standards: C37.74, C57.12.28 and ANSI 386

Voltage Range: 15kV

Current Ratings: 600A and 1200A continuous 3-phase load-break switches
200 ampere continuous 1-phase load-break elbows
Fusing to 200 amperes with current-limiting or power fuses

Switch 3-Phase
40ka asymmetrical 3-time fault closing
61ka asymmetrical 1-time fault closing
100 load-break operations at 600 amperes
UL® Recognized — 600A and 1200A 15kV switches
1000 mechanical operations

Optional Features: Key Interlocks
Stainless Steel Enclosure
Stainless Steel Switches
Special Colors
Copper Bus
Fuse Storage
Base Spacers
Cable Supports
Provisions for Fault Indicators
Designs engineered to customer requirements

Users: Utility, Industrial, Military,
Universities, Correctional

Pad-Mounted Capacitor Banks

Description: Three-phase capacitor bank with or without controller
Single-Pole vacuum interrupters for switching
current limiting fuses for fault protection

Method of Operation: Manual or with Controller for Automatic Operation

Applicable Standards: C57.12.28, ANSI 386, Capacitors Switches to C37.66

Circuit Configurations: Per customer specification

Voltage Range: 15kV and 25kV

Current Ratings: 200 ampere continuous; 12,000 amperes rms symmetrical fault interrupting

BIL: 95kV and 125kV

Capacitors: Size to 3600kvar as specified by customer
Voltage as specified by customer

Switching Components: Vacuum Capacitor Switch

Protection Components: Current-Limiting Fuses selected by customer
Reactors for in-rush restraint

Control Power: Voltage transformer

Optional Features: Remote Control Kit  Pad-Mounted
Stainless Steel Enclosure  Substation Mounting
Surge Arresters  Custom Relaying
Integral Load Interrupters with Emergency Switching to 800 kvar
Designs engineered to customer requirements

Users: Industrial, Government, Utility
Fused Tap Dead-Front Pad-Mounted Switchgear — Type FTDF

Description: Single-Phase and Three-Phase Fused Taps with and without Integral Single-Pole Load-Interrupters Combined with 200-Ampere Bushing Wells

Method of Operation: Manual, Single-Pole

Circuit Configurations: 8 Standard one-line diagrams and 8 designs

Applicable Standards: C37.74, C57.12.28 and ANSI 386

Voltage Range: 15kV — 25kV

Current Ratings: 200 and 600 ampere continuous with 200-ampere, Single-phase integral load-break interrupters for switching with fuses 200 ampere continuous 1-phase load-break elbows Fusing to 200 amperes with current-limiting or power fuses

Optional Features: Key Interlocks Stainless Steel Enclosure Special Colors Copper Bus Mimic Bus Dead-front access to fuses

Users: Utility, Military, Universities, Correctional

A single-phase FTDF model is pictured above.

A typical three-phase FTDF Model is pictured above.
SWITCHGEAR DIVISION PRODUCT PROFILES

Primary Metering — Type PMDF Dead-Front and Type PMLF Live-Front

Description: Three-Phase Primary Metering Compartments
Method of Operation: Type PMDF Accommodates Single-Pole Switching with elbows
Type PMLF Accommodates Conventional, Stress-Cone Terminators
Circuit Configurations: Per Specifications
Applicable Standards: C37.74, C57.12.28 and ANSI 386
Voltage Range: 15kV — 25kV
Current Ratings: 200 ampere continuous 1-phase load-break elbows
Optional Features: Stainless Steel Enclosure
Copper Bus
Special Colors
200 Ampere Bushing Wells
600 Ampere Bushings
Mimic Bus
Indoor and Outdoor
Metering Transformers
Designs engineered to customer requirements
Users: Utility, Military, Universities, Correctional

Wall-Mounted Fuses

Description: Single-Phase and Three-Phase Fused Taps with and without Integral
Single-Pole Load-Interrupters in a Wall-Mounted Enclosure
Method of Operation: Manual, Single-Pole
Circuit Configurations: Two Standard One-Line Diagrams and Custom Designs
Applicable Standards: C37.74, C57.12.28 and ANSI 386
Voltage Range: 15kV — 25kV
Current Ratings: 200 ampere continuous 1-phase load-break elbows
Optional Features: Stainless Steel Enclosure
Copper Bus
Special Colors
200 Ampere Bushing Wells
600 Ampere Bushings
Mimic Bus
Indoor and Outdoor
Metering Transformers
Designs engineered to customer requirements
Users: Utility, Military, Universities, Correctional

Wall-Mounted Switches

Description: Three-Phase, Group-Operated Load-Interrupter Switches in a Wall-Mounted Enclosure
Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip
Circuit Configurations: One Standard One-Line Diagram and Custom Designs
Applicable Standards: C37.74, C57.12.28 and ANSI 386
Voltage Range: 5kV — 25kV
Current Ratings: 600 Amperes Accommodates 600 Ampere Elbows
200 Amperes Accommodates 200 Ampere Load-break Elbows
Switch 3-Phase
40ka asymmetrical 3-time fault-closing
61ka asymmetrical 1-time fault closing
100 load-break operations at 600 amperes
UL® Recognized — 600A, 1200A, 5kV, 15kV
1000 mechanical operations
Optional Features: Key Interlocks
Special Colors
Stainless Steel Enclosure
Stainless Steel Switches
Remote Control
Users: Utility, Military, Universities, Correctional
SWITCHGEAR DIVISION PRODUCT PROFILES

Substations

Description: Three-phase portable substations for temporary, permanent or emergency power distribution application requirements integrating high-voltage, transformer and low-voltage sections
Method of Operation: Manual, Automatic Source Transfer, SCADA Control, Shunt-Trip
Circuit Configurations: Engineered to customer requirements as a turn-key design
Applicable Standards: C37.74, C37.20.3, C37.20.4, C37.57 and C37.58
Voltage Range: 4.16kV through 138kV high-voltage sections
Current Ratings: 600 amperes and 1200 amperes
BIL: Based on system voltage requirements
Transformers: Dry-type through 10MVA at 38kV, Liquid-filled as customer specified
Switching Components: Load-break Switches, Vacuum Circuit Breakers
Protection Components: Fuses, Vacuum Circuit Breakers
Optional Features: Skid Mounted, Metering Requirements
Trailer Mounted, Monitoring Requirements
Caterpillar Treads, Relaying Requirements
Rail Wheels, Customer Specific Requirements
Users: Utility, Industrial, Military, Correctional Facilities, WWT Facilities, Universities

Distribution Vacuum Fault Interrupter

Description: Three-phase vacuum fault interrupters for automatic reclosing on circuits to establish that fault is not permanent
Method of Operation: Automatic tripping of vacuum circuit breakers
Circuit Configurations: Per customer specification
Applicable Standards: C37.60
Voltage Range: 15kV — 25kV
Current Ratings: 600 and 1200 amperes continuous; 12,000 amperes rms symmetrical fault interrupting.
Also available: 15kV 1000A Continuous
20kA Interrupting
27kV 800A Continuous
16kA Interrupting
BIL: 95kV to 125kV
Transformers: Voltage Transformer for Control Power
Switching Components: Vacuum Circuit Breakers
Protection Components: Vacuum Circuit Breakers
Optional Features: Various Trip Settings, Remote Control Kit
Pad-Mounted, Stainless Steel Enclosure
Substation Mounting, Surge Arresters
Visible Disconnect
Users: Industrial, Government, Utility
Switchgear Components

Description: Load-break interrupter switches; Fuse mountings; Insulators; Bushings and bushing wells; Micro-processor controls; Motor operators, Vacuum circuit breakers, etc.

Method of Operation: Manual, Automatic Source Transfer, SCADA Control

Circuit Configurations: Customer Specified

Applicable Standards: C37.57, C37.58, C37.20.3; ANSI 386

Voltage Range: 4.16kV — 38kV

Current Ratings: 200, 600 and 1200 amperes

BIL: 60kV through 200kV

Switching Components: Auto-jet® II Load-Interrupter Switches, Vacuum Load-Break Switches, Vacuum Circuit Breakers

Protection Components: Vacuum Circuit Breakers, Current-Limiting Fuses, Power Fuses

Optional Features: Per specification requirements

Users: Original Equipment Manufacturers
TYPE PSI/II MANUAL
LIVE-FRONT PAD-MOUNTED SWITCHGEAR
15kV • 25kV

The PSI/II Pad-Mounted Switchgear is Federal Pacific's line of live-front pad-mounted switchgear (available as UL® Listed) built to IEEE C37.74 requirements and features the fully tested and field proven Auto-jet® load-interrupter switch for switching three-phase circuits and the integral load-interrupter for single-phase load-break operation with fuses.

General
• 15kV and 25kV Class - both available as UL® Listed
• Proven Auto-jet® switching
• Ratings normally found only in metal-enclosed switchgear
• Meets IEEE C37.74 requirements including 3-time fault-closing on switches and fuse mountings
• Removable barriers using NEMA Class GPO-3 non-hygroscopic fiberglass reinforced polyester barriers
• 100% X-rayed cycloaliphatic epoxy insulators
• 11-gauge pickled-and-oiled steel, all welded construction
• Meets ANSI C57.12.28 cabinet security and enclosure finish requirements
• Stainless-steel door-handle covers and switch operating pockets
• Stainless-steel hinges and hinge pins
• Overlapping active-passive door system with 3-point auto-latch door mechanism, padlockable door handle and standard penta-head or optional hex-head security bolts
• Ventilation louvers not required, sufficient ventilation being attained through non-gasketed doors and roof
• Anti-condensation roof undercoating
• Positive Latch Indicator on fuse interrupters verifies fully latched condition

PSI/II Pad-Mounted Switchgear is designed to meet the switching and isolating requirements of electrical distribution systems with 15 pre-engineered switching configurations. There are UL® Listed standard units available to cover almost every situation — radial feed, loop feed and manual primary-selector switching. Special configurations and designs are available upon request. The three-time fault-close ratings, with the laboratory and field-proven Auto-jet® system, can solve both your “near substation” high fault-current and mid-point loop switching applications as well as “distant end-point” standard fault-current requirements.
Applications

PSI/II Pad-Mounted Switchgear lends itself to meet distribution system requirements, whether it is a simple radial feed or a complex loop system. With 3-pole, group-operated load-interrupter switches, 3-phase sets of single-pole fuses and solid bus taps all available as UL® Listed — applications are almost unlimited.

Radial Feed

PSI/II Pad-Mounted Switchgear provides isolation and fuse protection in radial systems. Radial systems are used where service reliability and load type do not warrant the increased investment of the more flexible loop system. The radial system is used where there are many lateral cables, each to serve a small number of dispersed loads.

Loop Feed

PSI/II Pad-Mounted Switchgear provides sectionalizing in a loop feed distribution system. This system, with loop cable attached to the source at two points and a “normally open” switch near the load mid-point, provides excellent manual sectionalizing. The Auto-jet® II switches are opened and closed as required to isolate a cable problem or faulted circuit condition and to provide complete service restoration.

Primary Selector Switch

PSI/II Pad-Mounted Switchgear units are applied as primary selector switches to serve critical loads. This allows manual restoration of service upon the loss of the preferred source.
Features

The basic switchgear enclosure has been designed to present the smallest possible profile commensurate with the generally accepted electrical clearances, operating procedures, component requirements and various methods of training and terminating underground distribution cable. These pad-mounted switchgear designs are UL® Listed.

Standard features include: heavy 11-gauge hot-rolled pickled-and-oiled steel, all welded construction, stainless-steel hinges and switch operating pockets, active/passive compartment access doors with 3-point auto-latch door mechanisms, padlockable door handles and penta-head security bolts. These standard features, along with a rugged tamper-resistant design, provide a unit that meets the stringent security requirements of ANSI C57.12.28.

Electrical integrity has been enhanced by the Auto-jet®II switching system, NEMA Class GPO-3 barriers, 100% x-rayed cycloaliphatic epoxy insulators and a wide choice of both power and current-limiting fuses. High quality steel, corrosion-resistant hardware, chemical cleaning and phosphatizing or zirconization, corrosion resistant epoxy-powder primer and a baked polyester-powder top-coat make the anti-corrosion coating system a leader in the industry. The standard finish color is pad-mount green, Munsell 7GY3.29/1.5.

Standard options let you select units that best serve your needs and operating practices. Options include: front barriers to meet either NESC or RUS specifications; base spacers to provide for increased cable terminating height; ground stirrups for convenient cable grounding; key interlocking for anti-paralleling and access control; and surge arresters. These are just a few of the many options listed on pages 18 and 19.

Barriers

Designing equipment to a minimum size consistent with electrical clearance requirements adds to the aesthetic qualities of pad-mounted switchgear. The use of interphase, phase-to-ground and dual-purpose front barriers enhance operation by field personnel. The dual-purpose barriers, in their normal hanging position, help prevent inadvertent contact with live parts. In addition, these barriers can be temporarily inserted into the open gap when the switch or fuse is open, but should not remain in this alternate position for more than one week. A removable, clear window panel above the switch dual-purpose barriers allows visual verification of the switch blade position with the barriers in their normal hanging position. A fixed metal panel is mounted above the dual-purpose barriers in the fuse compartments as a top barrier guide.

Some barrier systems while highly desirable, restrict the space available for installing and terminating high-voltage cables entering the switch and fuse compartments. To eliminate this restriction, Federal Pacific’s standard barrier system, in PSI/II switch and fuse compartments, incorporates unique "removable" barriers which allow removal of interphase barriers during cable installation . . . without removal of any hardware. With the switchgear completely de-energized, removal of these barriers from a compartment facilitates cable installation, termination and repair. In order to get this same freedom during installation, other barrier systems require time consuming disassembly and reassembly.
Auto-Jet® II Switch

The unique feature of the Federal Pacific PSI/II Pad-Mounted Switchgear is the Auto-jet®II 3-pole group-operated switch. The Auto-jet®II switch provides 600 amperes continuous and load-break at 15kV and 25kV, and to 40,000 amperes RMS/ASYM momentary and 3-time fault-close capability. Switches rated 1200 amperes continuous and interrupting are also available. The Auto-jet® II switch provides a unique method of load interruption, producing a laminated jet of air which extinguishes the arc. Auto-jet®II switches are designed to provide a safe and convenient means for 3-pole switching of distribution transformers, cable loops and laterals, and to provide manual selection of preferred and alternate sources.

All Auto-jet®II switches have a heavy-gauge steel frame which assures proper contact alignment and eliminates any problem of switch-to-enclosure alignment. 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 safe 3-time fault-closing capability and load interruption with the Auto-jet®II interrupter. The switch blades are made of high conductivity copper. Current transfer from the switchblade through the hinge terminal is accomplished by a unique current transfer means, consisting of a silver-plated beryllium copper louvered contact band encircling a silver-plated copper heavy walled precision bushing at the hinge point. Due to higher than normal current flow, magnetic forces tend to rotate the louvers on the contact band toward a vertical position, providing a higher contact pressure for fault-current duty.

Illustration of Auto-jet® II Switch Interrupter

| 15-kV Auto-jet® II Switch |

| 15-kV Auto-jet® II Switch Ratings |

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① These are nominal switch ratings. Rating of integrated pad-mounted unit is determined by lowest rated component and may be limited by fuse ratings. Use fuse rating charts on pages 15 and 17 to select proper short circuit values.

② Barriers installed.

③ The 3-time fault-close duty-cycle rating means that the device can be closed three times into rated fault-current and remain operable and able to carry and interrupt its rated load-current.

*1-time duty-cycle fault-closing rating is 61ka rms asymmetrical.
Auto-jet® II Loadbreak Fuse Mountings

Auto-jet® for SM-4 Refill Unit
Shown with SML-4Z Fuseholders

Auto-jet® for DBU, CMU or SMU-20 Fuse Unit
Shown with DBU Fuse Assemblies

Shown here are only two of the many fuses which can be used with the Auto-jet® fuse mountings. See pages 11 and 13 for a more complete listing of fuses compatible with Auto-jet® fuse mountings.

The wide selection of fuse models available in PSI/II Pad-Mounted Switchgear provides maximum flexibility in the design and protection of underground distribution systems. Load-break Auto-jet® fuse mountings accommodate S&C Types SM-4 and SMU-20, Eaton Type DBU, and Cooper Type CMU, NX and X-Limiter fuses in 15kV and 25kV class PSI/II units.

The Positive-Latch Indicator (PLI) on Federal Pacific load-break fuse mountings is a reliable innovative semaphore target that shows when fuse assemblies are fully closed and latched, ready for a subsequent load-break opening operation.

Illustration of Auto-jet® EZ-Latch Fuse Interrupter

Closed: Hookstick ready to open, latch properly engaged. See Positive Latch Indicator in photos at top of page.

Main contacts parted, puffer spring charged, latch disengaged.

Interrupter parted (internal).

Holder parted, Auto-jet® reset for next operation.

The Auto-jet® fuse mounting has a direct drive, integral load-break interrupter that permits single-pole live switching in single-phase or three-phase circuits by the use of an ordinary hotstick. The Auto-jet interrupter has a 3-time fault-close duty-cycle when the fuse is closed briskly without hesitation. The overall unit rating may be limited by the fuse rating.

The same unique laminated air-jet interrupter used in the three-pole group-operated switches is applied in the Auto-jet® load-break fuse mountings.
15kV Basic Units—Three-Phase

14.4kV Nominal • 17kV Maximum Design • 95 kV BIL

Circuit Diagrams with Compartment Numbers

PSI/II Pad-mounted Switchgear is designed for use only by qualified personnel trained to operate medium voltage (2.4kV - 34.5kV) switchgear. Users other than electric utilities are urged to use key interlocking devices as applicable. Should non-utility users elect not to use key interlocks, they must submit written certification that only qualified and trained personnel will operate the equipment, and that key interlock systems are not required.

Models PSI/II-4 and PSI/II-15 are only available to electric utilities.

All units are 51” high without base spacers. Do not use any dimensions for construction purposes.

To determine complete catalog number for PSI/II models with fuse compartments substitute for “*” shown as last figure in the catalog number listed below each diagram on this page the number shown in the following table:

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<td>S&amp;C Type SMU-20</td>
<td>5</td>
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<tr>
<td>2</td>
<td>Eaton DBU</td>
<td>7</td>
<td>Cooper (CT) X-Limiter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PSI/II-3</td>
<td>PSI/II-4</td>
<td>PSI/II-5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-1/2&quot; W x 44-1/2&quot; D</td>
<td>35-1/2&quot; W x 44-1/2&quot; D</td>
<td>35-1/2&quot; W x 58-1/2&quot; D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PSI/II-3

Cat. No. 42100

PSI/II-4

Cat. No. 4201*

PSI/II-5

Cat. No. 4211*

PSI/II-6

67" W x 58-1/2" D

Cat. No. 4321*

PSI/II-61

67" W x 72" D

Cat. No. 4431*

PSI/II-7

67" W x 58-1/2" D

Cat. No. 4312*

PSI/II-8

67" W x 58-1/2" D

Cat. No. 4412*

PSI/II-9

67" W x 58-1/2" D

Cat. No. 4422*

PSI/II-10

67" W x 58-1/2" D

Cat. No. 44400

PSI/II-11

67" W x 58-1/2" D

Cat. No. 4313*

PSI/II-12

67" W x 58-1/2" D

Cat. No. 4413*

PSI/II-13

67" W x 58-1/2" D

Cat. No. 44300

PSI/II-131

67" W x 58-1/2" D

Cat. No. 43300

PSI/II-14

67" W x 58-1/2" D

Cat. No. 4421*

PsI/II PSI/II-15

67" W x 58-1/2" D

Cat. No. 4403*
Current Ratings - 15kV Basic Units

15kV Basic Units
Switch Only Units, PSI/II -3, -10, -13, -131

<table>
<thead>
<tr>
<th>Fuse Only &amp; Switch/Fuse Units: PSI/II -4, -5, -6, -61, -7, -8, -9, -11, -12, -14, -15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuse Manufacturer and Type</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>S&amp;C SM-4</td>
</tr>
<tr>
<td>S&amp;C SMU-20</td>
</tr>
<tr>
<td>S&amp;C SM-5</td>
</tr>
<tr>
<td>Eaton DBU</td>
</tr>
<tr>
<td>Cooper CMU</td>
</tr>
<tr>
<td>Cooper (M-E) NX</td>
</tr>
<tr>
<td>Cooper (CT) X-Limiter</td>
</tr>
</tbody>
</table>

For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

- SM-4 fused units require three S&C Cat. No. 92352 SML-4Z fuseholders and three S&C SM-4 fuse refills per fuse compartment.
- SMU-20 fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.
- DBU fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.
- CMU fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.
- NX fused units require three sets of Auto-jet® II end fittings (see table below) and three appropriately rated fuses per fuse compartment.
- NOTE: NX Clip Style non-loadbreak fuse mountings are available and will accommodate up to 200 ampere NX fuses.
- X-Limiter fused units require three sets of Auto-jet® II end fittings (see table below) and three appropriately rated fuses per fuse compartment. X-Limiter end fittings suitable for installation of complete fuse assemblies in SML-20 Power Fuse Mountings are also available. Consult factory for availability.
25kV Basic Units—Three-Phase

25kV Nominal • 29kV Maximum Design • 125 kV BIL

Circuit Diagrams with Compartment Numbers

PSI/II Pad-mounted Switchgear is designed for use only by qualified personnel trained to operate medium voltage (2.4kV - 34.5kV) switchgear. Users other than electric utilities are urged to use key interlocking devices as applicable. Should non-utility users elect not to use key interlocks, they must submit written certification that only qualified and trained personnel will operate the equipment, and that key interlock systems are not required.

Models PSI/II-4 and PSI/II-15 are only available to electric utilities.

All units are 61" high without base spacers. Do not use any dimensions for construction purposes.

To determine complete catalog number for PSI/II models with fuse compartments substitute for "*" shown as last figure in catalog number listed below each diagram on this page the number shown in the following table:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S&amp;C Type SM-4</td>
</tr>
<tr>
<td>2</td>
<td>S&amp;C Type SMU-20</td>
</tr>
<tr>
<td>3</td>
<td>Not applicable</td>
</tr>
<tr>
<td>4</td>
<td>Eaton DBU</td>
</tr>
<tr>
<td>5</td>
<td>Cooper (M-E) Type NX</td>
</tr>
<tr>
<td>6</td>
<td>Cooper (CT) X-Limiter</td>
</tr>
</tbody>
</table>

<p>| PSI/II-6 | PSI/II-61 | PSI/II-7 | PSI/II-8 |</p>
<table>
<thead>
<tr>
<th>82&quot; W x 74-1/2&quot; D</th>
<th>82&quot; W x 90&quot; D</th>
<th>82&quot; W x 74-1/2&quot; D</th>
<th>82&quot; W x 74-1/2&quot; D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cat. No. 5321*</td>
<td>Cat. No. 5431*</td>
<td>Cat. No. 5312*</td>
<td>Cat. No. 5412*</td>
</tr>
</tbody>
</table>

1 S&C Type SM-4 3 Not applicable
2 S&C Type SMU-20 5 Cooper (M-E) Type NX
2 Eaton DBU 7 Cooper (CT) X-Limiter
Current Ratings - 25kV Basic Units

25kV Basic Units
Switch Only Units, PSI/II -3, -10, -13, -131

Auto-jet® II Switch Ratings - Amps RMS

<table>
<thead>
<tr>
<th>Continuous Current</th>
<th>Load and Loop Switching</th>
<th>Short-Circuit Withstand Current (Sym.)</th>
<th>3-Time Fault-Close (Asym.)</th>
<th>Peak Withstand Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>600</td>
<td>600</td>
<td>12,500</td>
<td>20,000</td>
<td>32,500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25,000*</td>
<td>40,000*</td>
<td>65,000</td>
</tr>
</tbody>
</table>

*UL® Listed equipment is available at 25kA sym./40kA asym.

Fuse Only & Switch/Fuse Units: PSI/II -4, -5, -6, -61, -7, -8, -9, -11, -12, -14, -15

<table>
<thead>
<tr>
<th>Fuse Manufacturer and Type</th>
<th>Unit Overall Ratings Amperes RMS</th>
<th>Fuse Ratings Amperes RMS</th>
<th>3-Time Fault-Close RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Continuous</td>
<td>Load and Loop Switching</td>
<td>Short Circuit</td>
</tr>
<tr>
<td>S&amp;C SM-4†</td>
<td>20,000</td>
<td>540</td>
<td>200</td>
</tr>
<tr>
<td>S&amp;C SMU-20</td>
<td>20,000</td>
<td>540</td>
<td>200</td>
</tr>
<tr>
<td>S&amp;C SM-5</td>
<td>CONTACT FACTORY</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eaton DBU</td>
<td>20,000</td>
<td>540</td>
<td>200</td>
</tr>
<tr>
<td>Cooper CMU</td>
<td>20,000</td>
<td>540</td>
<td>200</td>
</tr>
<tr>
<td>Cooper (M-E) NX</td>
<td>40,000</td>
<td>1,080</td>
<td>1</td>
</tr>
<tr>
<td>Cooper (CT) X-Limiter</td>
<td>40,000</td>
<td>1,080</td>
<td>1</td>
</tr>
</tbody>
</table>

† 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 For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

2 SM-4 fused units require three S&C Cat. No. 92353 SML-4Z fuseholders and three S&C SM-4 fuse refills per fuse compartment.

SMU-20 fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.

DBU fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.

CMU fused units require three FP-3097 fuse-unit end fittings and any three of one of the following fuse units: S&C SMU-20, Eaton DBU or Cooper CMU, per fuse compartment.

NX fused units require three sets of Auto-jet® II end fittings (see table below) and three appropriately rated fuses per fuse compartment.

X-Limiter fused units require three sets of Auto-jet® II end fittings (see table below) and three appropriately rated fuses per fuse compartment. X-Limiter end fittings suitable for installation of complete fuse assemblies in SML-20 Power Fuse Mountings are also available. Consult factory for availability.

Fuse Only & Switch/Fuse Units: PSI/II -4, -5, -6, -61, -7, -8, -9, -11, -12, -14, -15

<table>
<thead>
<tr>
<th>Fuse</th>
<th>Fuse Amperes</th>
<th>Mtg. Code</th>
<th>End Fittings Catalog No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.5</td>
<td>6 - 140</td>
<td>5</td>
<td>0021-2-03059#</td>
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<tr>
<td>15.5</td>
<td>50 - 125</td>
<td>6</td>
<td>0021-2-03055</td>
</tr>
<tr>
<td>23</td>
<td>6 - 40</td>
<td>6</td>
<td>0021-2-03055</td>
</tr>
</tbody>
</table>

# Includes a code 6 to code 5 adapter.

3 For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

4 For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

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

6 Three-time fault-close rating: The Auto-jet® II 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. The fuse must be replaced following a fault-closing. Refer to S&C instruction manual for SML-4Z holder and SML-20 end fitting maintenance required after each fault-close or fault interruption.

7 Contact the factory for SM-5 applications.

8 These fuses are not available in UL® Listed models.
Optional Features

BASE SPACER — MILD STEEL
Non-compartmented (Applicable to all models)
A2 .......................... 6" to increase cable terminating height
A3 .......................... 12" to increase cable terminating height
A4 .......................... 18" to increase cable terminating height
A5 .......................... 24" to increase cable terminating height

Compartmented (Applicable to all models)
A6 .......................... 6" to increase cable terminating height
A7 .......................... 12" to increase cable terminating height
A8 .......................... 18" to increase cable terminating height
A9 .......................... 24" to increase cable terminating height

BASE SPACER — STAINLESS STEEL
Non-compartmented (Applicable to all models)
A2 .......................... 6" to increase cable terminating height
A3 .......................... 12" to increase cable terminating height
A4 .......................... 18" to increase cable terminating height
A5 .......................... 24" to increase cable terminating height

Compartmented (Applicable to all models)
A6 .......................... 6" to increase cable terminating height
A7 .......................... 12" to increase cable terminating height
A8 .......................... 18" to increase cable terminating height
A9 .......................... 24" to increase cable terminating height

BARRIERS

Dual-Purpose Barriers
These barriers are standard on all units. In the normal hanging position they help prevent inadvertent contact with live parts. They can be inserted into the open gap when switch or fuse is open.
B1  Switch barriers, one for each switch. Applicable to all models except PSI/II-4 & PSI/II-15.
B2  Fuse barriers, one for each fuse. Applicable to all models except PSI/II-3, -10, -13 & -131.

Inner Barrier*
B4  Hinged insulating barrier, one for each door opening secured with recessed penta-head bolt. Meets RUS *dead-front* requirements. Applicable to all models.
B5  Hinged insulating barrier, same barrier as B4, except hex-head security bolt. (Not RUS approved).

FUSE STORAGE HOOKS
Hooks to hang three* spare fuseholders or fuse units with end fittings on fuse compartment door.
E1  Compartment 3. Applicable to PSI/II-61, -7, -8, -9, -12 & -15.
E3  Compartment 3 & 4. Applicable to PSI/II-7, -8, -9, -12, & -15.
E4  Compartment 1. Applicable to PSI/II-4, -12, -15.
E5  Compartment 2. Applicable to PSI/II-5.
*Only two AJ-NX fuseholders can be accommodated on each fuse door. Not available with SM-5S power fuses.

FINISH COLOR & SPECIAL CABINET MATERIAL
(Applicable to all models)
F2  ANSI 61 light gray
F3  ANSI 70 sky gray
F4  Exterior Only of Type 304 Stainless Steel cabinet
F5  Coal Tar coating on lower three inches of enclosure or optional base spacer
F6  All Type 304 Stainless Steel Cabinet and (or non-ferrous) hardware, except switch frame and all current-carrying parts
F7  Same as F6 except with all stainless steel switch except current-carrying parts

GROUND STUDS
These ground studs are standard in each unit. One is provided on each terminal, plus one per compartment to provide a convenient means of grounding with jumpers.
G1  In all fuse compartments. Applicable to all models except PSI/II-3, -10, -13, & -131.
G2  In all switch compartments. Applicable to all models except PSI/II-4, & -15.
G3  In all bus termination compartments. Applicable to PSI/II-3, -4, -8, -13, -14 & -15.

KEY INTERLOCKS AND SECURITY BOLTS
Name of ultimate user, installation number and location of pad-mounted switchgear required with order.
K1  Anti-parallel key interlocks to prevent paralleling switches in Compartments 1 & 2. Applicable to PSI/II-6, -61**, -9, -10, -11, -13, -131 & -14.
K2  Provisions to padlock switch in open or closed position. All models except PSI/II-4 & -15.
K3  Key interlock to prevent opening fuse access door until all switches are locked open. Applicable to PSI/II-5, -6, -61**, -7, -8, -9, -11, -12 & -14.
K4  Anti-parallel and fuse access key interlock to prevent paralleling of switches in Compartments 1 & 2 and to prevent opening fuse access door until all switches are locked open. Applicable to PSI/II-6, -61**, -9, -11 & -14.
H  Hex-head security bolts in lieu of standard penta-head security bolts on all access doors. Applicable to all models.

** Between switches in Compartments 2 & 3 on PSI/II-61.
† Between tap switch (Compartment 1) and fuse access door (Compartment 4) on PSI/II-61.
†† On PSI/II-61, anti-parallel is between switches in compartments 2 & 3, and fuse access door (Compartment 4) is key interlocked with tap switch in Compartment 1.

* Meets the requirements of Section 381.6 of the National Electrical Safety Code and ANSI standard C2.
Optional Features

CABLE AND TERMINATION ACCESSORIES

Cable Supports (includes cable brackets) ①

| T3 | One for each switch terminal and bus terminal accommodating #2 through 1000 kc mil conductor. Applicable to all models. |
| T4 | One for each fuse terminal accommodating #2 through 4/0 conductor. Applicable to all models except PSI/II-3, -10, -13, and -131. |

Terminal Adapters

| T5 | Terminal adapter to accommodate two NEMA 1-hole or 2-hole connectors per terminal at each switch and bus terminal. For maximum cable size of 750 kc mil. Applicable to all models. |

Fault Indicator Provisions

| T6 | Mounting provisions only. To accommodate one three-phase fault indicator in each switch compartment (in compartments 2 and 3 only on PSI/II-61). Applicable to all models except PSI/II-4 and PSI/II-15. For LED-Type fault indicators, consult factory. |
| T7 | Mounting provisions only with viewing window. To accommodate one three-phase fault indicator in each switch compartment (in compartments 2 and 3 only on PSI/II-61) with fault indicator viewing window on associated door. Applicable to all models except PSI/II-4 and PSI/II-15. For LED-Type fault indicators, consult factory. |

MISCELLANEOUS

| C | Copper Bus (main and all termination points) ① |

① Heavy-duty, polymer-housed surge arresters (without isolator) or equal, for 0-12,000 ft. elevation. Base mounted arresters are standard. For other arrester mounting styles, consult the factory.

Heavy-duty, polymer-housed surge arresters (without isolator) or equal, for 0-12,000 ft. elevation. Base mounted arresters are standard. For other arrester mounting styles, consult the factory.

Optional Features

** These devices may extend below the base of the unit. Provide a cable pit or specify a base spacer.

APPLICATION GUIDE

Nominal System Suggested Arrester Rating

<table>
<thead>
<tr>
<th>Line-to-Line Voltage ①</th>
<th>4 Wire Multi-Grounded Neutral System</th>
<th>Delta Ungrounded &amp; Resistance or Resonance Wye Systems Grounded</th>
</tr>
</thead>
<tbody>
<tr>
<td>4,160</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>7,200</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>7,620</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>8,320</td>
<td>6</td>
<td>9, 10</td>
</tr>
<tr>
<td>12,000</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>12,470</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>13,200</td>
<td>9, 10</td>
<td>15</td>
</tr>
<tr>
<td>13,800</td>
<td>10, 12</td>
<td>15</td>
</tr>
<tr>
<td>20,780</td>
<td>15, 18</td>
<td>21</td>
</tr>
<tr>
<td>22,860</td>
<td>18</td>
<td>27</td>
</tr>
<tr>
<td>24,940</td>
<td>18</td>
<td>27</td>
</tr>
</tbody>
</table>

① Application of specified rating may be permissible for ungrounded or resistance grounded systems where a single-phase ground may be tolerated for a period of time not to exceed the arrester’s power frequency over-voltage capability.
STANDARD SPECIFICATION FOR LIVE-FRONT 15KV AND 25KV PSI/II PAD-MOUNTED SWITCHGEAR

A. General

1. Product

The pad-mounted switchgear shall be PSI/II design as manufactured by Federal Pacific and shall conform to the following specification.

2. Assembly

The pad-mounted switchgear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, including sensing, controls, and control power supply, all completely factory-assembled and operationally checked.

3. Ratings

a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below: (Select 15kV or 25kV sets of ratings from the tables below.

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>15kV†</th>
<th>25kV†</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV, Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>kV, Maximum Design</td>
<td>17.5</td>
<td>27§</td>
</tr>
<tr>
<td>kV, BIL</td>
<td>95</td>
<td>125</td>
</tr>
<tr>
<td>Main Bus Continuous, Amps</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>800</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

Switch Short-Circuit Ratings

- Amps, RMS Symmetrical: Standard 14,000 12,500; HFC 25,000 25,000
- Peak Withstand Current, Amperes: Standard 36,400 32,500; HFC 65,000 65,000
- MVA, 3-Phase Symmetrical at Rated Nominal Voltage: Standard 350 540; HFC 620 1,080
- Fault-Closing Amps, RMS, Asym., 3-Time Duty-Cycle Switch: Standard 22,400 20,000; HFC 40,000 40,000

- These are nominal switch ratings. Integrated pad-mounted unit may be limited by fuse ratings. Use fuse rating chart in next column to select proper short circuit ratings.
- Select one set of the ratings shown. (Standard or High Fault Current - HFC)
- 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.
- Maximum design of the 27kV switch is 29kV.

- For UL® Listed units, ratings are 15.5kV, 14,000 or 25,000 amperes rms symmetrical, 350 MVA, 22,400 or 40,000 amperes fault closing; and 27kV, 25,000 amperes rms symmetrical, 1080 MVA, 40,000 amperes asymmetrical fault closing.

b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses with integral load-interrupters shall equal or exceed the short-circuit ratings of the pad-mounted switchgear.

4. Certification of Ratings:

The manufacturer shall be completely and solely responsible for the performance of the basic switch and load-interruption components as well as the complete integrated assembly as rated.

5. Compliance with Standards and Codes

The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

b) Article 490.21(E) "Load Interrupters" in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

c) All portions of IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.

d) All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

The manufacturer shall furnish, upon request, certification of ratings of the basic switch components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure.
The following optional feature may be specified:

e) The pad-mounted switchgear shall be UL® Listed.

6. Enclosure Design

a) To ensure a completely coordinated design, the pad-mounted switchgear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

b) In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, ventilation and corrosion resistance.

B. Construction - Assembly

1. Insulators

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

a) Operating experience of at least 20 years under similar conditions.

b) Ablative action to ensure non-tracking properties.

c) Adequate leakage distance established by test per IEC Standard 60507.

d) Adequate strength for short-circuit stress established by test.

e) Conformance with applicable ANSI and IEEE standards.

f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

g) Each insulator shall be x-rayed to assure it is void free. An alternate testing method may be used only by approval of the engineer.

2. High-Voltage Bus

a) Bus and interconnections shall consist of bare aluminum bar with an oxide-inhibiting agent at all bus joints.

b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2” - 13 bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut or with a wide, flange-head carriage bolt and one Belleville spring washer under the nut per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e. 1-bolt and spring washer. Bolts shall be tightened to an appropriate foot-pounds torque.

d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

3. Ground-Connection Pads

a) A ground-connection pad shall be provided in each compartment of the pad-mounted gear.

b) The ground-connection pad shall be constructed of 1/4” thick stainless steel, which shall be welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

C. Construction - Enclosure and Finish

1. Enclosure

a) The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

b) The basic material for the enclosure, roof and doors shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet.

c) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. Bolted structural joints are not permitted.

d) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

e) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

f) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

g) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.

h) Enclosure top side edges shall overlap with roof side edges and form an internal maze to create an interface which shall allow ventilation of high-voltage compartments to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

i) A heavy coat of insulating “no-drip” compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.

j) Insulating interphase and end barriers of NEMA GP0-3 grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings.
k) Full-length steel barriers shall separate side-by-side compartments and barriers of the same material shall separate the front compartments from the rear compartments.

l) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be an open mesh to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

m) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.

n) Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

o) Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

p) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any unground weld butt joints exposed to the exterior.

2. Doors

a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.

b) Doors providing access to high voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

c) Doors providing access to high voltage shall have a minimum of three hinges. Door hinges shall be of stainless steel with stainless steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

d) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage shall be equipped with an automatic three-point latching mechanism.

1) The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2) A penta-head socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

3) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches.

   i) It shall not be possible to access the penta-head actuator until the padlock is removed.

   ii) It shall not be possible to unlatch the mechanism until the padlock is removed.

   iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.

f) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

g) Each door shall be provided with a door holder of stainless steel located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

3. Finish

a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

b) All exterior seams shall be sanded or ground smooth for a pleasing appearance.

c) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing process before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs for a pleasing appearance.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7GY3.29/1.5, dark green.

h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide on request, certification that representative test panels, protected by the manufacturer’s finish system, have passed the coating system performance criteria in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.
D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be operated by means of stored-energy operators installed by the switch manufacturer.

c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

d) Interrupter switches shall be provided with a single-arm blade construction with parallel current paths for each phase for circuit closing including fault-closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades that can become out of sequence with a main blade shall not be permitted.

e) Interrupter switch blade supports shall be permanently fixed in place in a unified hinge contact assembly utilizing a louvered contact configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during momentary currents.

f) Switch-blade hinge contacts that have wiping contacts directly connected to switch terminals and can be pulled apart by cable connected to the switch terminals are specifically prohibited, such designs can present potential arcing faults if cables are pulled.

g) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with essentially no external arc or flame.

h) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time and to rapidly increase the dielectric gap.

i) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to insure arc extinction.

j) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.

k) Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

The following optional features may be specified:

l) Bracket-mounted distribution-class surge arresters, metal-oxide type (specify rating), shall be provided at all source switch terminals.

m) Switch terminals shall be provided with adapters to accommodate two cables per phase.

n) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment and (with or without, select one) a viewing window in the door.

o) Mounting provisions to accommodate LED-Type fault indicators. Holes for such fault indicators shall be plugged with a tamper-resistant arrangement for shipment.

2. Fuses

a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

b) Fuse-mounting jaw contacts shall incorporate an integral load-interrupter that shall comply with all the preferred and optional test requirements in IEEE C37.74 to permit live switching of fuses with a hookstick equipped with a grappler tool and shall have a 3-time duty-cycle fault-closing capability at the interrupting rating of 22,400 amperes symmetrical.

1) The integral load-interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.

2) The integral load-interrupter shall be in the current path continuously only during circuit interruption. Auxiliary blades or linkages shall not be used.

3) Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.

4) The integral load-interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.

5) Internal moving contacts of the integral load-interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.

6) Circuit interruption shall take place completely within the integral load-interrupter with essentially no external arc or flame.

7) The integral load-interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
8) Integral load-interrupters for fuses shall have a three-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse at the applicable voltage (14.4kV or 25kV). The duty-cycle fault-closing capability defines the level of available fault-current into which the fuse can be closed the three-times without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load-interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

9) To increase contact separation speed, integral load-interrupter contacts on the source side of the arcing area shall be spring assisted to retract and, thereby, reduce arcing time and to rapidly increase the dielectric gap.

10) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to insure arc extinction.

11) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.

c) Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.

d) Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

e) Fuse-mounting interrupter housing shall be provided with a target that protrudes and becomes visible only after the fuse has become fully latched, secured, closed and ready for opening.

f) Fuse-mounting interrupter housing shall incorporate a mechanical latching arrangement that shall capture the fuse contact rod on closing. On opening, the latching arrangement shall not release until after the circuit has been interrupted. The mechanical latching arrangement shall make certain that the fuse-contact rod does not rely solely on friction to keep the contacts engaged and to avoid premature contact separation during the circuit interrupting sequence.

E. Labeling

1. Hazard-Alerting Signs & Labels
   a) All external doors providing access to high voltage shall be provided with suitable hazard-alerting signs.

   b) The inside of each door providing access to high voltage shall be provided with a "Danger—High Voltage — Keep Out — Qualified Persons Only" sign.

   c) Each barrier providing access to an interrupter switch shall be provided with a sign indicating that "Switch Blades May Be Energized in Any Position" on both sides.

   d) Both sides of each barrier providing access to a fuse shall be provided with a sign indicating that "Fuses May Be Energized in Any Position".

   e) Any barriers used to guard against access to energized live parts shall be provided with a "Danger" sign on both sides.

   f) Dual-purpose barriers shall be provided with a label indicating that such barriers shall not be left inserted into the open gap for more than one week.

   g) Doors to fuse compartments shall include a label illustrating the correct latched condition for the integral load interrupter.

   h) Doors to fuse compartments shall include a label illustrating correct opening/closing switching operation for fuses with integral load interrupters.

   i) Removable barriers shall include a label stating that barrier should not be removed when the equipment is energized.

2. Nameplate, Ratings Labels, & Connection Diagrams

   a) The outside of both the front and back shall be provided with nameplates indicating the manufacturer’s name, catalog number, model number, and date of manufacture.

   b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings, including duty-cycle fault-closing capability and amperes, short-time, (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).

   c) A three-line connection diagram showing interrupter switches, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, and on the inside of each switch operating hub access cover.

F. Accessories

1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.

2. A fuse handling tool as recommended by the fuse manufacturer shall be furnished if noted by the purchaser in the specifications.
Features:

- Available as UL® Listed
- Live-front 600-Ampere Switch Compartments
- Live-front 200-Ampere Fuse Compartments
- Manual, Automatic Source Transfer, and SCADA Controlled
- An exceptional combination of switch (up to 5) and fuse (up to 5) compartments, including bus-tie configurations
- Meets IEEE C37.74 requirements, including 3-time fault-closing of switches.
- Meets enclosure security requirements in ANSI C57.12.28

The Federal Pacific 6-Compartment Live-Front PSI/II Pad-mounted Switchgear (available as UL® Listed) expands the load segmentation possibilities for underground distribution systems by allowing larger concentrated loads to be served from a single enclosure, requiring less space and less expense.

Federal Pacific 6-Compartment, Live-front Pad-mounted Switchgear (available as UL® Listed) provides the convenience of installing a single enclosure with two 600-ampere switches and up to four three-phase sets of fuses. Installations with concentrated loads can now be served from a single switchgear assembly. The six-compartment configurations require less land space than two four-compartment units, which was the only choice in the past. In addition, the 6-compartment units are more economical than two four-compartment units both in initial and installed costs. There is no sacrifice in operating flexibility and, as a result, an outage on the main-feeder cable can be readily isolated and sectionalized. For 8-compartment designs, consult factory.
Live-front switches utilize conventional, skirted terminators and eliminate the need for costly, difficult to handle 600-ampere elbow connectors.

Ground studs up front for clear access.

Switch terminals readily accessible for connection of skirted terminators.

Surge Arresters (optional, not visible) mount below and to the rear of switch terminals, out of the way when installing terminators or pulling of cable.

Cross-kinked roof lets water flow off enclosure.

All compartments ventilated at roof-line and at door flanges.

Set of three stainless steel hinges and hinge pins on each door.

Bottom flange of enclosure is gasketed to protect finish.

Enclosure integrity and security is assured with Federal Pacific Type PSI/II Pad-mounted Switchgear.

Dual-purpose barriers provide a second barrier against inadvertent contact with energized parts of switches. Barriers can be removed and slide between switch blade and upper contacts, isolating lower section from energized bus at top. Barriers are not to be installed in the slide-in position for more than one week.

Switch interphase barriers are removable to facilitate pulling and terminating cables when the unit is de-energized. Interphase barriers are not to be removed unless switchgear is completely de-energized, tested for voltage and grounded.

Compartment ground with two-hole NEMA pad for connection of concentric neutral cable and grounding clamps.

Self-latching door security system controls access to interior. Latching system includes hinged padlockable cover with overhang to shield padlock shackle. Penta-head bolt is not exposed when cover is padlocked; can be rotated clockwise or counterclockwise to open door. Interior latches do not have any fast moving parts.

Enclosure integrity and security is assured with Federal Pacific Type PSI/II Pad-mounted Switchgear.
Fuse compartment (at center) includes dual-purpose barriers, shown with barrier removed on center phase and normal hanging position on other two phases. Barriers are not to be left in the slide-in position for more than one week. Interphase barriers are not to be removed when the unit is energized. Temporary storage position for switch dual-purpose barrier is illustrated on door at left and for fuse dual-purpose barrier is illustrated on door at center.
Typical configurations for models of Federal Pacific Live-Front 6-Compartment Pad-mounted Switchgear. Consult factory for other available circuit configurations. Dimensions will vary depending on circuit configuration, however, a typical dimension for 15kV units is 59” H x 110.3” W x 58.5” D. Do not use dimensions for construction purposes.

Other designs not shown may be available. Consult factory for details.
Federal Pacific Manual Dead-Front Type PSE Pad-Mounted Switchgear meets or exceeds all ratings in IEEE C37.74, and with UL® Listing of both 15kV and 25kV models. The enclosure provides increased security of fuse and switch components from environmental concerns and enhanced isolation of medium-voltage circuits to limit exposure of operating personnel.

Federal Pacific PSE pad-mounts feature a low-profile, heavy-gauge enclosure with cross-kinked roof to eliminate potential for standing water. Stainless-steel hinges and hinge pins combined with the padlockable, self-resetting, three-point, auto-latch door security system assures durability while controlling access to the interior.

Double-door construction allows clear access to elbow terminations. Ground rods that are full width of door opening make grounding of circuits and installation of surge arresters easy to achieve using shotgun clampstick. Enclosure bottom flange includes gasketing to isolate and protect the finish during installation and throughout the service life of the switchgear. Galvanized-steel floor plate on bottom of compartment containing medium-voltage components isolates interior from moisture and ingress of other contaminates.

The electrostatically deposited, baked-on powder epoxy finish meets IEEE, ANSI and UL® requirements and provides a tough, durable high-gloss finish with protective qualities essential to insure long-term protection of the metal.
Manual Dead-Front
Pad-Mounted Switchgear

Enclosure integrity and security is assured with Federal Pacific pad-mounted switchgear.

Connection diagrams, hazard alerting labels, and ratings labels on each door provide obvious notice of exposure to high voltage and quick reference for operating personnel.

Open/closed labels in switch termination compartments serve as supplemental indicator target to help orient and verify actual switch position.

Parking stands adjacent to each bushing (or bushing well).

Wide, mar-resistant polycarbonate window allows easy verification of three-phase group-operated switch position.

Ground rod of 3/8” copper extends full width of door openings.

Figure 3
Switch termination compartments allow visual verification of switch blade position and clear access to elbow terminations in Federal Pacific Dead-front PSE Pad-Mounted Switchgear.
Figure 4

Interior view of fuse-termination compartment of Federal Pacific PSE Pad-Mounted Switchgear includes many features to assure ease of operation for operating personnel when switching, inspecting and re-fusing 200-ampere circuits.
PSE Pad-Mounted Switchgear is designed for use only by qualified personnel trained to operate medium-voltage switchgear. Users other than electric utilities are required to use key interlocking devices as applicable. Should non-utility users elect not to use key interlocks, they must submit written certification that only qualified and trained personnel will operate the equipment, and that key interlock systems are not required.

Model PSE-4 is available only to electric utilities.

All units are 45” high without base spacers.

To determine complete catalog number for PSE models with fuse compartments substitute for “*” shown as last figure in catalog number listed below each diagram on this page the number shown in the following table:

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<th>Catalog No.</th>
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1 S&C Type SM-4  3 Not applicable
2 S&C Type SMU-20 5 Cooper (M-E) Type NX
2 Eaton DBU  7 Cooper (CT) X-Limiter
2 Cooper Type CMU
Current Ratings - 15 kV Basic Units

15kV Basic Units
Switch Only Units, PSE -3, -10, -13

<p>| Auto-jet® II Switch Ratings - Amps RMS |
|---------------------------------------|---------------------------------|---------------------------------|</p>
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<thead>
<tr>
<th>Continuous Current</th>
<th>Load and Loop Switching</th>
<th>Short-Circuit Withstand Current (Sym.)</th>
<th>3-Time Fault-Close (Asym.) *</th>
<th>Peak Withstand Current</th>
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* Three-time fault close rating. The Auto-jet® switch can be closed into a fault of the magnitude specified three times and remain operable and able to carry and interrupt the rated current.

**UL® Listed equipment is available at both 14kA sym/22.4kA asym and 25kA sym./40kA asym.

Switch/Fuse Units: PSE-5, -6, -7, -8, -9, -11, -12, -14

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<tr>
<td>Cooper (CT) X-Limiter</td>
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1. SM-4 fused units require three S&C Cat. No. 86632R2 SM-4Z fuseholders and three S&C SM-4 fuse refills per fuse compartment.

2. For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

3. SM-5 fuses cannot be used in PSE Pad-Mounted Switchgear. Contact the factory fuse-unit for SM-5 applications.

4. Unit overall ratings are limited to the lowest component rating.

5. Ratings expressed in RMS amperes asymmetrical are 1.6 times the symmetrical values listed.
25kV Basic Units-Three-Phase
25kV Nominal • 27kV Maximum Design • 125 kV BIL
Circuit Diagrams with Compartment Numbers

PSE Pad-Mounted Switchgear is designed for use only by qualified personnel trained to operate medium-voltage switchgear. Users other than electric utilities are required to use key interlocking devices as applicable. Should non-utility users elect not to use key interlocks, they must submit written certification that only qualified and trained personnel will operate the equipment, and that key interlock systems are not required.

Model PSE-4 is available only to electric utilities.

All units are 51” high without base spacers.

To determine complete catalog number for PSE models with fuse compartments substitute for “*” shown as last figure in catalog number listed below each diagram on this page the number shown in the following table:

<table>
<thead>
<tr>
<th>No.</th>
<th>Fuse Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>S&amp;C Type SM-4</td>
</tr>
<tr>
<td>2</td>
<td>S&amp;C Type SMU-20</td>
</tr>
<tr>
<td>2</td>
<td>Eaton DBU</td>
</tr>
<tr>
<td>2</td>
<td>Cooper Type CMU</td>
</tr>
<tr>
<td>3</td>
<td>Not applicable</td>
</tr>
<tr>
<td>5</td>
<td>Cooper (M-E) Type NX</td>
</tr>
<tr>
<td>7</td>
<td>Cooper (CT) X-Limiter</td>
</tr>
</tbody>
</table>

PSE-3 46” W x 81-3/4” D

PSE-4 46” W x 79-1/2” D

PSE-5 46” W x 81-3/4” D

PSE-6 84” W x 81-3/4” D

PSE-7 84” W x 81-3/4” D

PSE-8 84” W x 81-3/4” D

PSE-9 84” W x 81-3/4” D

PSE-10 84” W x 88-1/4” D

PSE-11 84” W x 88-1/4” D

PSE-12 84” W x 81-3/4” D

PSE-13 84” W x 88-1/4” D

Catalog No. 52100
Catalog No. 5201*
Catalog No. 5211*
Catalog No. 5321*
Catalog No. 5312*
Catalog No. 5412*
Catalog No. 5422*
Catalog No. 54400
Catalog No. 5431*
Catalog No. 5413*
Catalog No. 54300
Current Ratings - 25kV Basic Units

25kV Basic Units
Switch Only Units, PSE

<table>
<thead>
<tr>
<th>Auto-jet® II Switch Ratings - Amps RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous Current</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>600</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

* Three-time fault close rating. The Auto-jet® II switch can be closed into a fault of the magnitude specified three times and remain operable and able to carry and interrupt the rated current.
**UL® Listed equipment is available at 25kA sym./40kA asym.

Switch/Fuse Units: PSE-5, -6, -7, -8, -9, -11, -12, -14

<table>
<thead>
<tr>
<th>Fuse Manufacturer and Type</th>
<th>Unit Overall Ratings</th>
<th>Fuse Ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Momentary ASYM</td>
<td>MVA 3-Phase SYM at 25kV</td>
</tr>
<tr>
<td>S&amp;C SM-4</td>
<td>20,000</td>
<td>540</td>
</tr>
<tr>
<td>S&amp;C SMU-20</td>
<td>20,000</td>
<td>540</td>
</tr>
<tr>
<td>Eaton DBU and Cooper CMU</td>
<td>20,000</td>
<td>540</td>
</tr>
<tr>
<td>Cooper (M-E) Type NX</td>
<td>40,000</td>
<td>1,080</td>
</tr>
<tr>
<td>Cooper (CT) X-Limiter</td>
<td>40,000</td>
<td>1,080</td>
</tr>
</tbody>
</table>

1. SM-4 fused units require three S&C Cat. No. 86632R2 SM-4Z fuseholders and three S&C SM-4 fuse refills per fuse compartment.

2. SM-20 fused units require three Federal Pacific FP-3097 fuse end fittings and three S&C SMU-20, Eaton DBU or Cooper CMU fuse units per fuse compartment.

3. DBU fused units require three Federal Pacific FP-3097 end fittings and three Eaton DBU, Cooper CMU or S&C SMU-20 fuse units per fuse compartment.

4. NX fused units require three appropriately rated fuses per fuse compartment.

5. X-Limiter fused units require three appropriately rated fuses per fuse compartment.

6. CMU fused units require three Federal Pacific FP-3097 end fittings and three Cooper CMU, Eaton DBU or S&C SMU-20 fuse units per fuse compartment.

7. For fuse application and ordering information, refer to the applicable fuse manufacturer literature.

8. SM-5 fuses cannot be used in PSE Pad-mounted Switchgear. Contact the factory for SM-5 applications.

9. 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.

10. Unit overall ratings are limited to the lowest component rating.

11. Ratings expressed in RMS amperes asymmetrical are 1.6 times the symmetrical values listed.
Optional Features

**BASE SPACER — MILD STEEL**

**Non-compartmented (Applicable to all models)**

A2 .............................. 6” to increase cable terminating height
A3 .............................. 12” to increase cable terminating height
A4 .............................. 18” to increase cable terminating height
A5 .............................. 24” to increase cable terminating height

**Compartmented (Applicable to all models)**

A6 .............................. 6” to increase cable terminating height
A7 .............................. 12” to increase cable terminating height
A8 .............................. 18” to increase cable terminating height
A9 .............................. 24” to increase cable terminating height

**BASE SPACER — STAINLESS STEEL**

**Non-compartmented (Applicable to all models)**

AS2 ............................ 6” to increase cable terminating height
AS3 ............................ 12” to increase cable terminating height
AS4 ............................ 18” to increase cable terminating height
AS5 ............................ 24” to increase cable terminating height

**Compartmented (Applicable to all models)**

AS6 ............................ 6” to increase cable terminating height
AS7 ............................ 12” to increase cable terminating height
AS8 ............................ 18” to increase cable terminating height
AS9 ............................ 24” to increase cable terminating height

**BUS**

C ............................. Copper Bus (main and all termination points)

**FUSE STORAGE HOOKS**

Hooks to hang three complete fuse assemblies on fuse-compartment door.

E2  Compartment 4. Applicable to PSE-6, -11
E4  Compartment 1. Applicable to PSE-5, -6, -7, -8, -9, -11
E5  Compartment 2. Applicable to PSE-6, -7, -8, -9, -11, -12
E6  Compartment 3. Applicable to PSE-6, -7, -8, -9, -11, -12

**FINISH COLOR & SPECIAL CABINET MATERIAL**

(Applicable to all models)

F2  ANSI #61 light gray
F3  ANSI #70 sky gray
F4  Type 304 stainless-steel cabinet (exterior only)
F5  Coal Tar coating on lower three inches of enclosure or optional base spacer
F6  All Type 304 Stainless-Steel Cabinet and internal parts (or non-ferrous) hardware, except switch frame and all current-carrying parts.

**KEY INTERLOCKS AND SECURITY BOLTS**

Name of ultimate user, installation number and location of pad-mounted switchgear required with order.

H  Hex-head security bolts in lieu of standard penta-head security bolts on all access doors. Applicable to all models.
K1  Anti-paralleling key interlocks to prevent paralleling switches in Compartments 1 & 2. Applicable to PSE-6, -9, -10, -11, -13.
K2  Provisions to padlock switch in open or closed position. All models except PSE-4.
K3  Key interlock to prevent opening fuse access door until all switches are locked open. Applicable to PSE-5, -6, -7, -8, -9, -11, -12.
K4  Anti-paralleling and fuse access key interlock to prevent paralleling of switches in Compartments 1 & 2 and to prevent opening fuse access door until all switches are locked open. Applicable to PSE-6, -9, -10, -11, -12

**FAULT INDICATOR PROVISIONS**

T6  Mounting provisions only. To accommodate one three-phase fault indicator in each switch compartment. Applicable to all models except PSE-4.
T7  Mounting provisions only with viewing window, to accommodate one three-phase fault indicator in each switch compartment with fault indicator viewing window on associated door. Applicable to all models except PSE-4.

For LED-Type Fault Indicators and other special options, consult factory.
A. General

1. Product
   The pad-mounted gear shall be in accordance with the applicable plans, drawings and one-line diagrams and shall conform to these specifications.

2. Assembly
   The outdoor pad-mounted gear shall consist of a single self-supporting enclosure, containing three-phase group operated interrupter switches and three-phase sets of single-pole fuses with the necessary accessory components, all completely factory assembled and operationally checked.

3. Coordination
   To ensure a completely coordinated design, the pad-mounted gear shall be integrally designed and produced by the manufacturer of the basic switching equipment.

4. Ratings
   Ratings for the integrated pad-mounted assembly shall be as designated below

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>15kV†</th>
<th>25kV†</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV, Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>kV, Maximum Design</td>
<td>17.5</td>
<td>27.1</td>
</tr>
<tr>
<td>kV, BIL</td>
<td>95</td>
<td>125</td>
</tr>
<tr>
<td>Main Bus Continuous, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

```
Switch Short-Circuit Ratings ①②

<table>
<thead>
<tr>
<th>Amps, RMS Symmetrical</th>
<th>Standard 14,000</th>
<th>12,500</th>
<th>HFC 25,000</th>
<th>25,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Withstand Current, Amperes</td>
<td>Standard 36,400</td>
<td>32,500</td>
<td>HFC 65,000</td>
<td>65,000</td>
</tr>
<tr>
<td>MVA, 3-Phase Symmetrical at Rated Nominal Voltage</td>
<td>Standard 350</td>
<td>540</td>
<td>HFC 620</td>
<td>1,080</td>
</tr>
<tr>
<td>Fault-Closing Amps, RMS, Asym., 3-Time Duty-Cycle③</td>
<td>Standard 22,400</td>
<td>20,000</td>
<td>HFC 40,000</td>
<td>40,000</td>
</tr>
</tbody>
</table>
```

① These are nominal switch ratings. Integrated pad-mounted unit may be limited by fuse ratings. Use fuse rating chart in next column to select proper short circuit ratings.
② Select one set of the ratings shown. (Standard or High Fault Current - HFC)
③ 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.
④ Maximum design of the 27kV switch is 29kV.
⑤ Maximum current rating of the fuse mounting is 22,400 amperes rms asymmetrical. Fuse mounting ratings can be increased to the fuse-interrupting rating ONLY if the current-limiting fuse limits the let-through current to a value equal to or less than the short-circuit rating of the fuse mounting. Refer to current-limiting fuse manufacturer.
⑥ Models with this fuse-type are not UL® Listed.
⑦ Check with the factory for UL® Listing.
⑧ Applicable to solidly-grounded-neutral systems only with fuses connected by a single conductor concentric neutral type cable to a transformer or transformers. Rating is 9,400 amperes RMS symmetrical, 15,000 amperes RMS asymmetrical (405 MVA symmetrical) for all other applications.
⑨ SM-5 fuses cannot be used in PSE Pad-mounted Switchgear. Contact factory for SM-5 applications.

5. Certification of Ratings
   The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated pad-mounted gear assembly as rated.

   The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure. This certification of the integrated unit shall include testing the pad-mounted gear to the fault-close requirements of the specification to assure the bus support system and components are adequate.

The following optional feature may be specified:

a) The pad-mounted switchgear shall be UL® Listed.

6. Submittals

When requested, the manufacturer shall furnish the following drawings and reports:

a) Layout showing dimensions, arrangements, electrical ratings, components and weights.

b) Certified test reports of similar manufactured units showing fault-closing capability and load-interrupting capability of switches and complete pad-mounted gear assembly based on maximum design voltage.

7. Compliance with Standards & Codes
   The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

a) All portions of ANSI/IEEE C57.12.28, covering enclosure integrity for pad-mounted equipment.
b) Article 490.21(E) ”Load Interrupters” in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

c) All portions of IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.

d) All portions of ANSI, IEEE, and NEMA standards applicable to the basic switch and fuse components.

8. Enclosure Design
To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access and tamper resistance.

B. Construction - Assembly
1. Insulators, Bushings and Bushing Wells
The interrupter-switch and fuse-mounting insulators and the bushings and bushing wells shall have the following material characteristics and restrictions:

a) Operating experience of at least twenty (20) years under similar conditions.

b) Ablative action to ensure non-tracking properties.

c) Adequate leakage distance established by test per IEC Standard 60507.

d) Adequate strength for short-circuit stress established by test.

e) Conformance with applicable ANSI standards.

f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator, bushing and bushing well to provide maximum resistance to power arcs. Ablation due to high temperature from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulating components during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulating components with minor surface damage need not be replaced.

g) Each insulator, bushing and bushing well shall be x-rayed to assure it is essentially void free. An alternate testing method may be used only by approval of the engineer.

h) Conductor rods of bushings and bushing wells shall be of all copper with silver flash at threaded studs.

2. High-Voltage Bus
a) Bus and interconnections shall consist of bare aluminum bar of 56% IACS conductivity with an oxide-inhibiting agent at all bus joints.

b) Bus and interconnections shall withstand the stresses associated with short circuits up through the maximum rating of the pad-mounted gear, including proper allowance for transient conditions.

c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of non-corrosive bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut, or with a wide, flange-head bolt and one Belleville spring washer under the nut per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e., 1-bolt and spring washer. Bolts shall be tightened to an appropriate torque to assure good electrical connection.

d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

3. Ground-Connection Pads
a) A ground connection pad shall be provided in each termination compartment of the pad-mounted gear.

b) The ground connection pad shall be constructed of 1/4” thick, stainless steel and have a NEMA 2-hole pattern for ground connections. The pad shall be welded to the enclosure and shall have a short-circuit rating equal to that of the integrated assembly.

c) A full width copper grounding rod shall be provided in each cable-termination compartment.

C. Construction - Enclosure & Finish
1. Enclosure
a) The pad-mounted enclosure shall be of unitized construction (not structural frame and bolted sheet) to maximize strength, minimize weight, and inhibit internal corrosion.

b) The basic material for the enclosure, roof and doors shall be 11-gauge, hot-rolled, pickled-and-oiled steel sheet.

c) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. A welding process shall be employed that eliminates alkaline residues and minimizes distortion and spatter.

d) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

e) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

f) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

g) In consideration of tamper resistance, the enclosure shall conform to or exceed the requirements of ANSI/IEEE C57.12.28.

h) A heavy coat of insulating “no-drip” compound shall be applied to the inside surface of the roof to reduce condensation of moisture thereon. The roof shall be removable with bolts accessible in termination compartments.

i) Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A protective material shall be placed between the lifting tabs and the enclosure to prevent the tabs from scratching the enclosure finish. This material shall be non-hygrosopic to prevent moisture from being absorbed.

j) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any unground weld butt joints exposed to the exterior.

The following optional feature may be specified:

k) A steel (specify compartmented or non-compartmented) base spacer shall be provided to increase the elevation
of live parts in the pad-mounted gear above the mounting pad by (specify 6, 12, 18, 24) inches.

2. Barrier Assembly

Insulating barriers shall be provided in each switch and fuse compartment as required to achieve necessary insulation levels. This barrier system shall be constructed of fiberglass reinforced polyester (NEMA rated GPO-3).

3. Doors

a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.

b) Door edge flanges shall overlap with door opening flanges and shall be formed to create a mechanical maze that shall guard against water entry or discourage tampering or insertion of foreign objects.

c) Doors shall have a minimum of three stainless steel hinges and hinge pins. The hinge pins shall be secured in place to guard against tampering.

d) One active and one passive door shall be provided. In consideration of controlled access and tamper resistance, each active door shall be equipped with a positive-action three-point auto-latch mechanism and padlock hasp.

e) Each active door shall be provided with a hinged stainless-steel cover over the operating bolt. The cover shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering and access to the operating bolt. Each handle shall be provided with a recessed penta-head (hex optional) bolt for additional security.

f) Each passive door shall be independently secured and latched to the enclosure and shall not require a tool for opening.

g) Doors providing access to fuses shall have provisions to store spare expulsion type fuse units or refills.

h) Each door shall be provided with a stainless-steel door holder located above the door opening. These holders shall be hidden from view when the door is closed. It shall not be possible for the holders to swing inside the enclosure.

4. Finish

a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

b) All exterior seams shall be sanded or ground smooth for neat appearance.

c) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing process before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7GY3.29/1.5, dark green.

h) To ensure that the finishing system is capable of resisting corrosion, the manufacturer shall provide on request, certification that representative test panels, protected by the manufacturer’s finish system, have passed the coating system performance requirements in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.

D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short circuit rating of the integrated pad-mounted gear assembly. These ratings define the ability to close the interrupter switch either alone (unfused) or in combination with the appropriate power fuses three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum design voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall utilize a quick-make, quick-break mechanism installed by the switch manufacturer. The quick-make, quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the speed of the switch operating handle.

c) Interrupter switches shall be operated by means of an externally accessible switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted enclosure. The switch-operating hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Labels or targets to indicate switch positions shall be provided in the switch operating hub pocket.

d) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a rigid mounting frame. The frame shall be of heavy-gauge steel construction.

e) Interrupter switch shall be provided with contact blades and interrupters for circuit closing, including fault-closing, continuous current carrying, and circuit interrupting. Spring loaded auxiliary blades shall not be permitted.

f) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence.

g) Interrupter switches shall have a readily visible open gap when in the open position, which shall be viewable through a mar-resistant clear barrier, to allow positive verification of correct switch position. In addition, an open/close label shall be provided in the termination compartment to give a supplemental visual indication of switch position.

h) Each interrupter switch shall be provided with a switch operating handle. The switch-operating handle shall be secured to the inside of the switch-operating hub pocket and shall be stored behind the switch-operating hub access cover.

i) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time and to rapidly increase the dielectric gap.

j) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to insure arc extinction.
k) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.

The following optional features may be specified:

l) Key interlocks shall be provided to prevent paralleling the two source interrupter switches.

m) Key interlocks shall be provided to guard against opening fuse compartment door(s) unless all switches (series tap switch only, where furnished) are locked open.

n) Provision to padlock switch-operating hub in open or closed position shall be provided.

o) Cable guides shall be provided to help orient cables at switch and bus compartment terminals.

p) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each switch compartment (except series tap switch, where furnished). External holes for fault indicators shall include a tamper-resistant arrangement where fault indicators are not shipped installed.

q) Mounting provisions to accommodate LED-Type Fault Indicators. Holes for such fault indicators shall be plugged for shipment with tamper-resistant arrangement.

r) To facilitate installation of elbow-connected surge arresters or grounding elbows, a set of three 200-ampere bushing wells shall be provided in each switch-termination compartment without increasing the height or depth of the basic unit.

2. Switch Compartments

a) Switch terminals shall be equipped with 600 ampere rated bushings that include removable silver-plated copper threaded studs to accommodate a choice of termination systems.

b) Bushings and bushing wells shall have interfaces in accordance with ANSI/IEEE Standard 386 (ANSI Standard C119.2) to accept all standard separable insulated connectors and inserts.

c) Parking stands are provided adjacent to each bushing and bushing well to accommodate horizontal feed-throughs and standoff insulators.

d) All medium-voltage switch and fuse components are completely encased in an inner grounded steel compartment. The component compartment floor shall be of 18-gauge galvanized steel sheet to exclude foliage and animals. The floor shall be cross-kinked and shall have a small stainless-steel screen in each corner.

e) Viewing windows are provided within the termination compartments to allow visual verification of switch position, observation of switch-position open/close labels and inspection of blown-fuse indicators on power fuses.

3. Fuse Compartments

a) Fuse terminals are equipped with 200 ampere rated bushing wells designed to accept 200 ampere bushing inserts and shall have removable, silver-plated copper studs.

b) Bushings and bushing wells shall have interfaces in accordance with ANSI/IEEE Standard 386 (ANSI Standard C119.2) to accept all standard separable insulated connectors and inserts. Parking stands are provided adjacent to each bushing and bushing well to accommodate horizontal feed-throughs and standoff insulators.

c) Fuse access panels shall have a mechanical interlock that guards against gaining access to the fuse before opening the load-break separable insulated connector at the fuse terminal.

d) The fuse shall be accessible only when de-energized and isolated — for full-view load-break disconnection and removal with a shotgun stick. This mounting features positive latching in both the energized and de-energized positions. When latched in the open position, the de-energized fuse is electrically isolated and readily observable to operating personnel for removal with full visibility of contact interfaces on both sides of the fuse.

e) Access to the compartment containing energized components when fuses are being changed shall be blocked by a GPO-3 panel that is secured in position.

f) Individual parking stands shall be provided for each fuse mounting to allow convenient installation of elbow accessories to accommodate grounding. A ground rod shall be installed across the full width of the fuse compartments for connecting of cable concentric neutrals. Fuse phases shall be equipped with cable guides to assist in cable training and to prevent cables from interfering with movement of the fuse-access panel.

g) To provide maximum service life and to prevent corrosion of moving parts, all latches and pivots in the fuse-handling mechanism shall be either painted steel, stainless steel, or zinc-plated.

The following optional features may be specified:

h) Fuse storage hooks shall be provided on fuse-termination compartment access door(s). Each set of hooks shall allow the storing of three complete fuse assemblies for power fuses. Storage hooks shall be for two holders when current-limiting fuses are used.

E. Labeling

1. Warning Signs

All external doors shall be provided with approved “WARNING — HIGH VOLTAGE — KEEP OUT” signs.

2. Nameplate, Ratings Labels & Connection Diagrams

a) The outside of both the front and back shall be provided with nameplates indicating the manufacturer’s name, catalog number, model number, and date of manufacture.

b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings, including duty-cycle fault-closing capability and amperes, short-time, RMS (momentary asymmetrical and one-second symmetrical). A label indicating equipment is UL® Listed shall be included when applicable.

c) A three-line connection diagram showing interrupter switches, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, and on the inside of each switch-operating hub access cover.

F. Accessories

End fittings or holders, and fuse units or refill units for original installation, as well as spare fuse unit or refill unit for each fuse mounting, shall be furnished in accordance with the client’s requirements when specified.
The 6-Compartment Federal Pacific Dead-Front PSE Pad-Mounted Switchgear (available as UL® Listed) expands the load segmentation possibilities for underground distribution systems by allowing larger concentrated loads to be served from a single enclosure, requiring less space and less expense.

Federal Pacific 6-Compartment, Dead-Front PSE Pad-Mounted Switchgear provides the convenience of installing a single enclosure with two 600-ampere switches and up to four three-phase sets of fuses, or five 600-ampere switches in a bus-tie arrangement. Installations with concentrated loads can now be served from a single switchgear assembly. The six-compartment configurations require less land space than two four-compartment units, which was the only choice in the past. In addition, the 6-compartment units are more economical than two four-compartment units.

Features:
- Available as UL® Listed
- Dead-Front 600-Ampere Switch Compartments
- Dead-Front 200-Ampere Fuse Compartments
- Manual, Automatic Source Transfer, and SCADA Controlled
- 5-600 ampere switches in a bus-tie arrangement
- 4—600-ampere switches plus two sets of fused feeders in a single enclosure
- 2—600-ampere switches plus four sets of fused feeders in a single enclosure
- Meets all preferred and optional ratings in IEEE C37.74.
- Meets Enclosure Security requirements in ANSI C57.12.28
- Other configurations as needed, consult factory
- 1200-ampere models, consult factory
Enclosure integrity and security is assured with Federal Pacific Dead-Front Type PSE Pad-Mounted Switchgear.

Dead-Front switches, in compartments on left and on right, utilize 600-ampere bushings, accommodating 600-ampere elbow connectors. Dead-Front fuses in center compartment accommodate 200-amp load-break inserts and elbows.
Interior view of fuse-termination compartments of Federal Pacific Dead-Front 6-Compartment Pad-Mounted Switchgear accommodates a wide variety of fuses rated to 200-amperes.
15kV Dead-Front Circuit Configurations

Typical configurations for models of Federal Pacific Dead-Front 6-Compartment Pad-Mounted Switchgear. Consult factory for other available circuit configurations. Dimensions vary depending on circuit configuration, however, a typical dimension is 50"H x 123"W x 72.75"D. Do not use dimensions for construction purposes.
Federal Pacific SCADA Switchgear for Distribution Automation and Smart Grids

Due to the growth of Distribution Automation and Smart Grid technologies, implementation of SCADA (Supervisory Control and Data Acquisition) compatible switchgear has become increasingly important to both utilities and end users in order to better optimize the use of existing system resources and to affect improvements to reliability both at the system level and for the end user.

Federal Pacific SCADA controlled Live-Front SCPSI/II and Dead-Front SCPSE Pad-Mounted Switchgear permit automated switching and provide both supervisory control of switching operations and the data acquisition of system status, while still providing the still important function of fault protection and isolation for the URD / Underground distribution systems.

Specification of SCADA (or remotely controlled) Pad-Mounted Switchgear typically provides for a completely integrated, self-powered switching and protection package for automated distribution installations. The SCADA controlled switchgear would normally include interrupter switches, switch operator(s) and associated wiring, low-voltage compartments, and wiring. Some SCADA switchgear designs are available as UL® Listed, consult with the factory for details if this feature is desired.

Inclusions

The SCADA automation equipment typically includes current sensors (optional); a self-contained 120-volt 60-hertz power source (optional); battery with charger; and provisions for a remote terminal unit (RTU) that may be integrated, as selected by customer, with a modem for direct connection to a SCADA master computer by means of an optional land-line communication channel, an optional 900-Mhz transceiver or an optional fiber-optic transceiver. The switchgear may be optionally equipped with controls to provide automatic sectionalizing following overcurrents in excess of a preselected level and the subsequent loss of source-side voltage.

Federal Pacific Auto-Jet® II Switches

The 600-ampere and 1200-ampere Auto-Jet® II Switches provide three-pole live switching of three-phase circuits. One, two, three, or four Auto-Jet® II Switches may be power operated depending on the design selected. All live-front switch terminal pads can accommodate a variety of cable-terminating devices for cable sizes to 1000 kc mil. All dead-front switch terminals include a 600-ampere bushing to accommodate 600-ampere non-loadbreak elbow connectors.

Federal Pacific Motor Operators

Federal Pacific Motor Switch Operators provide power operation of the associated Auto-Jet® II Switch in response to a remote or local pushbutton signal. Federal Pacific Motor Operators include the following features as standard:

• An integral motor for power operating the quick-make quick-break mechanism of the Auto-Jet® II Switch.
• Open-close toggle switch for local electrical operation.
• Operation selector switch which permits local control using toggle switches while precluding remote operations, with remote indication of selector-switch position.
• Auxiliary-switch contacts for remote indication of switch position.
• Decoupler to permit operation of motor operator without affecting the position of the switch.
• Operation counter.
• A manual operating handle allows local manual operation of the Auto-Jet® II Switch in the event control power is not available.
Automation Equipment Groups
Federal Pacific SCADA Controlled Pad-mounted Switchgear may be purchased with the communication and automation control group to provide a completely self-sufficient automated distribution switching and protection unit. Alternately, they may be purchased with either a switch-automation group for use with RTU by others or with a switch-automation group for use without RTU. One of the automation control groups must be specified when ordering. Consult factory for optional controls that additionally provide automatic sectionalizing following overcurrents in excess of a preselected level and the subsequent loss of source voltage.

Enclosure Construction
All low-voltage wiring is shielded from medium voltage and is routed either in a 24-inch control-wiring base spacer for live-front models or in a roof section on dead-front models, which are included with each model of Federal Pacific SCADA Pad-Mounted Switchgear and which increases enclosure height accordingly.

Enclosures containing medium voltage meet the requirements of ANSI C57.12.28 (Enclosure Integrity) and are of free-standing, self-supporting construction—not for bolting directly to transformers—with provisions for cable entrance and exit through the bottom. Access to the interiors of medium-voltage compartments is controlled by the standard self-latching mechanism. The latching mechanism provides automatic three-point door latching on closing and permits padlocking only when the door is securely latched. The door can be opened only with a pentahead socket wrench or tool. Enclosures for low-voltage components (i.e. switch operators, RTU, etc.) are typically a NEMA 4 enclosure with padlock and security tabs.

The enclosure roof over each medium-voltage compartment is undercoated with an insulating “no-drip” compound. A resilient closed-cell gasket on the bottom flange of the pad-mounted gear protects the finish from being scratched during installation and isolates it from direct contact with the concrete foundation. Similar gasketing is provided between the switch operators or low-voltage compartment and the medium-voltage compartments. Enclosures are protected from corrosion by the Federal Pacific finishing system with the standard color of Munsell No. 7GY3.29/1.5, dark green.

Interphase and end barriers of fiberglass-reinforced polyester are provided with each switch and each set of fuses where required to achieve published BIL ratings. Additional barriers (where furnished) of the same material separate front and rear medium-voltage compartments and isolate the tie bus. Full-length steel barriers separate adjoining switch and fuse compartments (where applicable) in live-front models.

Optional Features

K3 – Key Interlock — Prevents access to fuse-compartment unless associated switch is locked open.
T1 – Installation of RTU — User provided RTU.
T11 – Installation of FP RTU — FP purchased and installed (type as specified by user).
T2 – Installation of Radio — User provided Radio.
T21 – Installation of Radio — FP provided and installed Radio (type as specified by user).
T3 – Installation of Antenna — User provided Antenna.
T31 – Installation of Antenna — FP provided and installed Antenna (type as specified by user).
X1 – Cold-Temperature Package — Modification to allow operation under low-temperature condition to -40°F (-40°C).
X2 – Temperature Compensation for Battery — Device to cool battery in hot climates to extend battery life and warms the battery to improve performance under cold conditions.

For other Optional Features please consult the factory.
A. General

1. Plans
   The Pad-Mounted gear shall be the SCPSI/II design as manufactured by Federal Pacific and shall conform to these specifications.

2. Assembly
   The basic pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses and separate, integral enclosure(s) including switch operator(s), controls, and control-power supply. It shall also provide the necessary accessory components, including sensing, controls, and control power input, all completely factory-assembled and operationally checked.

3. Ratings
   a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below: (Select 15kV or 25kV sets of ratings from the tables below)

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>15kV†</th>
<th>25kV‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kv, Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>Kv, Maximum Design</td>
<td>17.5</td>
<td>275</td>
</tr>
<tr>
<td>Main Bus Continuous, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses with integral load interrupter shall equal or exceed the short-circuit ratings of the pad-mounted switchgear.

4. Certification of Ratings:
   The manufacturer shall be completely and solely responsible for the performance of the basic switch components as well as the complete integrated assembly as rated.

   The manufacturer shall furnish, upon request, certification of ratings of the basic switch components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure.

The following optional feature may be specified:
   a) The pad-mounted switchgear shall be UL® Listed. Consult factory for details if this feature is desired.

5. Compliance with Standards and Codes
   The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:
   a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
   b) Article 490.21(E) “Load Interrupters” in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
   c) All portions of IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.
   d) All portions of ANSI and IEEE standards applicable to the basic switch components.

6. Enclosure Design
   a) To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
   b) In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

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**Fuse Ratings**

<table>
<thead>
<tr>
<th>Fuse Manufacturer</th>
<th>Fuse Type</th>
<th>Three-Phase MVA (Sym)</th>
<th>Amps RMS (Asym)</th>
<th>3-Time Fault-Close Asym</th>
<th>Cont. Amps</th>
<th>Load-Break Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>S&amp;C</td>
<td>SM-4</td>
<td>310</td>
<td>20000</td>
<td>20000</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>S&amp;C</td>
<td>SMU-20</td>
<td>350</td>
<td>22400</td>
<td>22400</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>S&amp;C</td>
<td>SM-5†</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Eaton</td>
<td>DBU</td>
<td>350</td>
<td>22400</td>
<td>22400</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Cooper (M-E)</td>
<td>NX</td>
<td>620</td>
<td>40000</td>
<td>40000</td>
<td>100*</td>
<td>100</td>
</tr>
<tr>
<td>Cooper (CT)</td>
<td>X-Limiter</td>
<td>620</td>
<td>40000</td>
<td>40000</td>
<td>140</td>
<td>140</td>
</tr>
<tr>
<td>Cooper</td>
<td>CMU</td>
<td>350</td>
<td>22400</td>
<td>22400</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

† For UL® carry and interrupt its rated load current.
‡ For UL® Listing.
§ Maximum design of the 27kV switch is 29kV.

| Models with this fuse type are not UL® Listed. | Check with the factory for UL® Listing. | Applicable to solidly-grounded-neutral systems only with fuses connected by a single conductor concentric neutral type cable to a transformer or transformers. Rating is 9,400 amperes RMS symmetrical, 15,000 amperes RMS asymmetrical (405 MVA symmetrical) for all other applications. | Please contact factory for SM-5 applications. |
B. Construction - Assembly

1. Insulators
   The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:
   a) Operating experience of at least 20 years under similar conditions.
   b) Ablative action to ensure non-tracking properties.
   c) Adequate leakage distance established by test per IEC Standard 60507.
   d) Adequate strength for short-circuit stress established by test.
   e) Conformance with applicable ANSI standards.
   f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.
   g) Each insulator shall be x-rayed to assure it is void free. An alternate testing method may be used only by approval of the engineer.

2. High-Voltage Bus
   a) Bus and interconnections shall consist of aluminum bar with an oxide-inhibiting agent on all bus joints.
   b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted switchgear.
   c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of non-corrosive bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut, or with a wide, flange-head bolt and one Belleville spring washer under the nut per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, (i.e. l-bolt and spring washer). Bolts shall be tightened to an appropriate torque to assure good electrical connection.
   d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

3. Ground-Connection Pads
   a) A ground-connection pad shall be provided in each compartment of the pad-mounted gear.
   b) The ground-connection pad shall be constructed of 1/4" thick stainless steel, which shall be welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

4. Low-Voltage Components
   a) All low-voltage components, including switch operators, controls, and control-power source shall be located in a grounded, steel-enclosed compartment separate from high voltage to provide isolation and shall be arranged to allow complete accessibility for test and/or maintenance without exposure to high voltage.
   b) Low-voltage wiring, except for short lengths such as at terminal blocks and the secondaries of sensing devices, shall be shielded where necessary for isolation from high voltage.

C. Construction - Enclosure & Finish

1. Enclosure
   a) The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.
   b) Separate integral, grounded, steel-enclosed low-voltage control compartments shall be provided for the switch operators, controls, and related communication equipment.
   c) The basic material shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet.
   d) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. Bolted structural joints are not permitted.
   e) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
   f) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
   g) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.
   h) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.
   i) Flanges at door openings on the low-voltage control compartment shall be provided with resilient compression gasketing around the entire door opening, and shall provide strength and rigidity for effective compression of the gasketing to prevent water entry.
   j) Enclosure top-side edges shall overlap with roof-side edges and form an internal maze to create an interface which shall allow ventilation of high-voltage compartments to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
   k) A heavy coat of insulating “no-drip” compound shall be applied to the inside under surface of the roof to minimize condensation of moisture thereon.
   l) Insulating interphase and end barriers of NEMA GP0-3 grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings.
   m) Full-length steel barriers shall separate side-by-side compartments and barriers of the same material shall separate the front compartments from the rear compartments.
   n) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient protective material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be an open mesh to prevent moisture from being absorbed and held between the
tabs and the enclosure in the event that lifting tabs are not removed.

o) A steel-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 24 inches and to house voltage transformer(s) required for control voltage input to battery charger or other optional sensors.

p) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.

q) Interruption switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gaps when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

r) Each fuse with an integral load-interrupter shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them (but only for a temporary time interval not to exceed one week) into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

s) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or anyunground weld butt joints exposed to the exterior.

2. Doors
a) Doors providing access to high voltage shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.

b) Doors providing access to high voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

c) Doors providing access to the low-voltage control compartment shall have 90-degree flanges providing a deep overlap with the door openings. To keep low-voltage components clean and dry, these doors shall be fully gasketed.

d) Doors shall have a minimum of three (for the basic enclosure) or two (for the low-voltage enclosure) stainless-steel hinges with stainless-steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-plated steel, and shall not be externally accessible to guard against tampering.

e) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage shall be equipped with an automatic three-point latching mechanism.

1) The latching mechanism shall be spring-loaded and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2) A penta-head socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

3) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

i) It shall not be possible to access the penta-head actuator until the padlock is removed.

ii) It shall not be possible to unlatch the mechanism until the padlock is removed.

iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.

f) Doors providing access to low-voltage components may be equipped with a three-point latching mechanism that need not be automatic and a door holder at the top or bottom of the door.

g) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

h) Each door providing access to high voltage shall be provided with a stainless steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

3. Ventilation Openings
a) Rain-resistant vents shall be provided on doors providing access to the low-voltage control compartment.

b) Each vent shall have an inside stainless steel screen and a baffle to protect against insertion of foreign objects and entry of insects.

4. Finish
a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

b) All exterior seams shall be filled and sanded smooth for neat appearance.

c) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs for a pleasing appearance.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7Gy3.29/1.5, dark green.

h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide, on request, certification that representative test panels, protected by the manufacturer’s finish system, have passed the coating system performance requirements in section 5.5.
of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.

i) To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc chromate plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall meet the preferred ratings in IEEE C37.74, including a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be operated by means of switch operators installed by the switch manufacturer.

c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

d) Interrupter switches shall be provided with a single-arm blade construction with parallel current paths for each phase for circuit closing including fault-closing, continuous current carrying, and separate contacts for circuit interrupting. Spring-loaded auxiliary blades that can become out of sequence with a main blade shall not be permitted.

e) Interrupter switch blade supports shall be permanently fixed in place in a unified hinge contact assembly utilizing a louvered contact band configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during momentary currents.

f) Switch-blade hinge contacts that have wiping contacts directly connected to switch terminals and can be pulled apart by cable connected to the switch terminals are specifically prohibited, such designs can present potential arcing faults if cables are pulled.

g) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter with essentially no external arc or flame.

h) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time.

i) To further ensure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and, thereby, not rely solely on blade travel to ensure arc extinction.

j) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or erode such components and materials.

k) Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

The following optional components can be selected:

j) Bracket-mounted distribution-class surge arresters, metal-oxide type (specify rating), shall be provided at all source switch terminals.

k) Switch terminals shall be provided with adapters to accommodate two cables per phase.

l) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment.

m) Mounting provisions to accommodate LED-Type fault indicators. Holes for such fault indicators shall be plugged with a tamper-resistant arrangement for shipment.

2. Fuses

a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

b) Fuse-mounting jaw contacts shall incorporate an integral load-interrupter that shall comply with all the preferred and optional test requirements in IEEE C37.74 to permit live switching of fuses with a hookstick equipped with a grappler tool and shall have a 3-time duty-cycle fault-closing capability at the interrupting rating of 22,400 amperes symmetrical.

1) The integral load-interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.

2) The integral load-interrupter shall be in the current path continuously during circuit interruption. Auxiliary blades or linkages shall not be used.

3) Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.

4) The integral load-interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.

5) Internal moving contacts of the integral load-interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.

6) Circuit interruption shall take place completely within the integral load-interrupter with essentially no external arc or flame.

7) The integral load-interrupter and the fuse shall be provided with fault-closing contacts and current-carrying contacts and separate contacts for circuit interrupting. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by current or interrupting contacts.
8) Integral load interrupters for fuses shall have a three-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse at 14.4kV or 25kV. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the three-times without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load-interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

9) To further ensure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and, thereby, not rely solely on blade travel to ensure arc extinction.

10) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or erode such components and materials.

c) Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.

d) Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

e) Fuse-mounting interrupter housing shall be provided with a target that protrudes and becomes visible only after the fuse has become fully latched, secured closed, and ready for opening.

f) Fuse-mounting interrupter housing shall incorporate a mechanical latching arrangement that shall capture the fuse contact rod on closing and on opening the latching arrangement shall not release until after the circuit has been interrupted. The mechanical latching arrangement shall make certain that the fuse-contact rod does not rely solely on friction to keep the contacts engaged and to avoid premature contact separation during the circuit interrupting sequence.

3. Switch Operators for Remote-Supervisory Control

a) Switch operators for remote-supervisory control shall be provided to operate the high-voltage source-interrupter switches. They shall be motor charged to trip-open and trip-close the switches.

b) Switch operators shall charge and trip a quick-make quick-break mechanism on the switch installed by the switch manufacturer, and shall have sufficient mechanical energy to open or close the associated interrupter switch. The quick-make quick-break mechanism shall swiftly and positively open and close the interrupter switch independent of the speed of the charging motor or manual handle.

c) Switch operators shall charge and trip the associated source-interrupter switch in response to a remote control signal.

d) Toggle switches or pushbuttons shall be provided to permit local electrical trip-open and trip-closed operation. Local pushbutton electrical operation shall be prevented when the operator is in the remote mode.

e) Switch operators shall be provided with a charging shaft and a removable manual handle to allow manual charging and tripping of the quick-make quick-break mechanism in the event that control power is lost.

f) Switch operators shall be located in a grounded, aluminum-enclosed low-voltage compartment. The compartment shall provide complete isolation from high voltage to help protect operating personnel.

g) Switch operators shall be equipped with indicators to show whether the associated source-interrupter switch is in the open or closed position.

h) Switch operators shall be provided with a decoupling feature to permit decoupling of the operator from the associated interrupter switch for testing and exercising of the switch operator and controls without opening or closing the interrupter switch and without exposure to high voltage.

i) When the switch operator is decoupled, the associated interrupter switch shall be locked in the position it was in at the time of decoupling. It shall not be possible to recouple the switch operator to the source-interrupter switch unless the switch operator is in the same position (open or closed) as the interrupter switch.

The following optional feature can be selected:

j) Switch operators shall be provided with an extra 4-PST auxiliary switch coupled to the source-interrupter switch.

4. Interface For Remote Operation

a) Interface Connections

1) The switch operator shall provide space for and shall allow for interfacing with a remote-terminal unit (RTU). The RTU shall be provided and installed by the user or may be optionally provided and installed by the supplier of the pad-mounted switchgear, or provided by the user and installed by the switchgear supplier, as designated in the user’s specification.

2) The interface shall include terminal points for connection to the RTU that allow for determination of whether the switch is in the open position or in the closed position.

3) The interface shall include terminal points for connection to the RTU that allow for determination of whether the battery (if so equipped) is providing adequate voltage for operating the system.

4) The interface shall include terminal points for connection to the RTU that allow for remote operation of the switch operator to open and close the switch when coupled.

5) The interface shall include terminal points for connection to the RTU that allow for remote indication of the status of the Local/Remote Selector Switch (if furnished)—either in the LOCAL or REMOTE position.

b) Control Features

1) A Local/Remote Selector Switch shall be furnished for choosing operating mode. In the ‘local’ mode, electrical trip-open and trip-closed operation by means of pushbuttons shall be enabled while remote switching shall be inhibited.

2) The battery and battery charger, if furnished, shall be located in a grounded, steel-enclosed low-voltage compartment. The control compartment shall provide isolation from high voltage.
The following optional features can be selected:

3) Light-emitting lamps shall be furnished for indicating the presence of acceptable voltage on the high-voltage source.

4) Separate light-emitting lamps shall be furnished for indicating the switch positions and the control operating mode (Local/Remote).

c) Voltage Sensing and Control Power

1) Voltage sensing and control power input shall be provided by one or more voltage transformers on the load side of the source-interrupter switch.

2) The output of the voltage transformers shall be directly proportional to line-to-ground voltage and shall have accuracy over an ambient temperature range suitable for the application.

3) Constant-current devices vulnerable to being open circuited and requiring a protective device for such eventuality and shorting-type terminal blocks shall not be used to provide voltage sensing or power for operation.

d) Current Sensing

1) Current sensing shall be provided to detect the level of load current as well as for fault detection and measurement. The feature shall include a light-emitting lamp for indicating when a fault condition has occurred, a reset button for manually resetting the overcurrent condition, and three current sensing devices for each source.

2) Provisions shall be furnished for manually resetting the overcurrent condition from a remote location.

The following optional features can be selected:

e) Voltage Sensing

Three-phase voltage sensing shall be provided. Voltage sensing devices for three-phase sensing shall be furnished on phases where voltage transformers are not utilized.

f) Remote Indication

Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence of source voltage and the operating mode — Local/Remote.

g) Supervisory Control

Supervisory control provisions shall be provided to permit switch operation from a remote location.

d) Both sides of each barrier providing access to a fuse shall be provided with a sign indicating that “Fuses May Be Energized in Any Position”.

e) Any barriers used to guard against access to energized live parts shall be provided with a “Danger” sign on both sides.

f) Dual-purpose barriers shall be provided with a label indicating that such barriers shall not be left inserted into the open gap for more than one week.

g) Doors to fuse compartments shall include a label illustrating the correct latched condition for the integral load interrupter.

h) Doors to fuse compartments shall include a label illustrating correct opening/closing switching operation for fuses with integral load interrupters.

i) Removable barriers shall include a label stating that barrier should not be removed when the equipment is energized.

2. Nameplate, Ratings Labels, & Connection Diagrams

a) The outside of both the front and back shall be provided with nameplates indicating the manufacturer’s name, catalog number, model number, and date of manufacture.

b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings, including duty-cycle fault-closing capability and amperes, short-time, RMS (momentary asymmetrical and one-second symmetrical).

c) A three-line connection diagram showing interrupter switches, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, inside the door of each motor operator, and on the inside of each switch-operating hub access cover.

F. Accessories

1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.

2. A fuse-handling tool (for use on a customer furnished hotstick) as recommended by the fuse manufacturer shall be furnished.

E. Labeling

1. Hazard-Alerting Signs & Labels

a) All external doors providing access to high voltage shall be provided with suitable hazard-alerting signs.

b) The inside of each door providing access to high voltage shall be provided with a ‘Danger — High Voltage — Keep Out — Qualified Persons Only’ sign.

c) Each barrier providing access to an interrupter switch shall be provided with a sign indicating that “Switch Blades May Be Energized in Any Position” on both sides.
STATEMENT SPECIFICATION FOR DEAD-FRONT
SCADA CONTROLLED PAD-MOUNTED SWITCHGEAR

A. General

1. Plans
   The pad-mounted gear shall be the SCPSE design as manufactured by Federal Pacific and shall conform to the following specification.

2. Assembly
   The basic pad-mounted gear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses and separate, integral enclosures including switch operator(s), controls, and control-power supply, and shall also provide the necessary accessory components, including sensing, controls, and control power input, all completely factory-assembled and operationally checked.

3. Ratings
   a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below:

   System Voltage Class
<table>
<thead>
<tr>
<th>Voltage</th>
<th>15kV</th>
<th>25kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>Design</td>
<td>17.5</td>
<td>27.3</td>
</tr>
<tr>
<td>Rating</td>
<td>95</td>
<td>125</td>
</tr>
<tr>
<td>Bus</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Load</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

   Switch Short-Circuit Ratings
<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>Amps, RMS Symmetrical</th>
<th>MVA, 3-Phase Symmetrical</th>
<th>At Rated Nominal Voltage</th>
<th>Fault-Closing Amps, RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>KV Nominal</td>
<td>14,000</td>
<td>12,500</td>
<td>25,000</td>
<td>1,080</td>
</tr>
<tr>
<td>KV Maximum Design</td>
<td>14,000</td>
<td>12,500</td>
<td>25,000</td>
<td>1,080</td>
</tr>
<tr>
<td>KV BIL</td>
<td>14,000</td>
<td>12,500</td>
<td>25,000</td>
<td>1,080</td>
</tr>
<tr>
<td>Main Bus Continuous, Amps</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>600</td>
<td>600</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

   b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses should equal or exceed the short-circuit ratings of the pad-mounted switchgear.

4. Certification of Ratings
   The manufacturer shall be completely and solely responsible for the performance of the basic switch components as well as the complete integrated assembly as rated.

   The manufacturer shall furnish, upon request, certification of ratings of the basic switch components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure.

   The following optional features may be specified:
   a) The pad-mounted switchgear shall be UL® Listed. Consult factory for details if this feature is desired.

5. Compliance with Standards and Codes
   The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:
   a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.
   b) Article 490.21(E) “Load Interrupters” in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safety withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
   c) All portions of IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.
   d) All portions of ANSI and IEEE standards applicable to the basic switch components.

6. Enclosure Design
   a) To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
   b) In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.
B. Construction - Assembly

1. Insulators
The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:
   a) Operating experience of at least 20 years under similar conditions.
   b) Ablative action to ensure non-tracking properties.
   c) Adequate leakage distance established by test per IEC Standard 60507.
   d) Adequate strength for short-circuit stress established by test.
   e) Conformance with applicable ANSI standards.
   f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.
   g) Each insulator shall be x-rayed to assure it is essentially void free. An alternate testing method may be used only by approval of the engineer.

2. High-Voltage Bus
   a) Bus and interconnections shall consist of aluminum bar with an oxide-inhibiting agent on all bus joints.
   b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted switchgear.
   c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of non-corrosive bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut, or with a wide, flange-head bolt and one Belleville spring washer under the nut per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e. 1-bolt and spring washer. Bolts shall be tightened to an appropriate torque to assure good electrical connection.
   d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

3. Ground-Connection Pads
   a) A ground-connection pad shall be provided in each compartment of the pad-mounted gear.
   b) The ground-connection pad shall be constructed of 1/4” thick steel (stainless steel or galvanized), which shall be welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

4. Low-Voltage Components
   a) All low-voltage components, including switch operators, controls, and control-power source shall be located in a grounded, steel-enclosed compartment separate from high voltage to provide isolation and shall be arranged to allow complete accessibility for test and/or maintenance without exposure to high voltage.
   b) Low-voltage wiring, except for short lengths such as at terminal blocks and the secondaries of sensing devices, shall be shielded where necessary for isolation from high voltage.

C. Construction - Enclosure & Finish

1. Enclosure
   a) The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.
   b) Separate integral, aluminum low-voltage control compartments shall be provided for the switch operators, controls, and related communication equipment.
   c) The basic switchgear enclosure material shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet.
   d) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. A welding process shall be employed that eliminates alkaline residues and minimizes distortion and spatter.
   e) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
   f) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
   g) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.
   h) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.
   i) Flanges at door openings of the low-voltage control compartment shall be provided with resilient compression gasketing around the entire door opening, and shall provide strength and rigidity for effective compression of the gasketing to prevent water entry.
   j) A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to reduce condensation of moisture thereon. The roof shall be removable with bolts accessible in termination compartments.
   k) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient protective material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be an open mesh to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.
   l) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any unground weld butt joints exposed to the exterior.
   m) A steel-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted
gear above the mounting pad by 12 inches and to accommodate optional sensors that may be required.

n) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.

2. Doors

a) Doors providing access to high voltage shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.

b) Doors providing access to high voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

c) Doors providing access to the low-voltage control compartment shall have 90-degree flanges providing a deep overlap with the door openings. To keep low-voltage components clean and dry, these doors shall be fully gasketed.

d) Doors shall have a minimum of three (for the basic enclosure) or two (for the low-voltage enclosure) stainless-steel hinges with stainless-steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-plated steel and shall not be externally accessible to guard against tampering.

e) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage shall be equipped with an automatic three-point latching mechanism.

   1) The latching mechanism shall be spring loaded and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

   2) A penta-head socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

   3) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

      i) It shall not be possible to access the penta-head actuator until the padlock is removed.

      ii) It shall not be possible to unlatch the mechanism until the padlock is removed.

      iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.

f) Doors providing access to low-voltage components may be equipped with a three-point latching mechanism, that need not be automatic and a door stop at the top or bottom of the door.

g) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

h) Each high-voltage compartment door shall be provided with a door holder located above the door opening. The holder shall be hidden from view when the door is closed and it shall not be possible for the holder to swing inside the enclosure.

3. Ventilation Openings

a) Rain resistant vents shall be provided on doors providing access to the low-voltage control compartment.

b) Each vent shall have an inside stainless-steel screen and a baffle to protect against insertion of foreign objects and entry of insects.

4. Finish

a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

b) All exterior seams shall be filled and sanded smooth for neat appearance.

c) All surfaces shall undergo a chemical cleaning, phosphatizing or zincation, and sealing process before any protective coatings are applied in order to remove oils and dirt, to form a chemically and anodically neutral conversion coating, to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7GY3.29/1.5, dark green.

h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide on request, certification that representative test panels, protected by the manufacturer’s finish system, have passed the coating system performance requirements in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.

i) To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc chromate plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value with the switch remaining operable and able to carry and interrupt rated current.

Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be operated by means of switch operators installed by the switch manufacturer.

c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single
rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

d) Interrupter switches shall be provided with a single-arm blade construction with parallel current paths for each phase for circuit-closing including fault-closing, and continuous current carrying, and separate contacts for circuit interrupting. Spring-loaded auxiliary blades that can become out of sequence with a main blade shall not be permitted. Interrupter switch blade supports shall be permanently fixed in place in a unified hinge contact assembly utilizing a louvered contact band configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during momentary currents.

e) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter with essentially no external arc or flame.

f) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time.

g) To further ensure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and, thereby, not rely solely on blade travel to ensure arc extinction.

h) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or erode such components and materials.

i) Switch terminals shall connect to 600-ampere bushings to accommodate 600-ampere elbows.

The following optional components can be selected:

j) Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment.

k) Provision to padlock switch-operating hub in open or closed position shall be provided.

l) Cable guides shall be provided to help orient cables at switch and bus compartment terminals.

2. Switch Compartments

a) Switch terminals shall be equipped with 600 ampere rated bushings that include removable silver-plated copper threaded studs to accommodate a choice of termination systems.

b) Bushings and bushing wells shall have interfaces in accordance with ANSI/IEEE Standard 386 (ANSI Standard C119.2) to accept all standard separable insulated connectors and inserts.

c) Parking stands are provided adjacent to each bushing and bushing well to accommodate horizontal feed-throughs and standoff insulators.

d) All medium-voltage switch and fuse components are completely encased in an inner grounded steel compartment. The component compartment floor shall be of 18-gauge galvanized steel sheet to exclude foliage and animals. The floor shall be cross-kinked and shall have a small stainless-steel screen in each corner.

e) Viewing windows are provided within the termination compartments to allow visual verification of switch position, observation of switch-position open/close labels and inspection of blown-fuse indicators on power fuses.

3. Fuse Compartments

a) Fuse terminals are equipped with 200 ampere rated bushing wells designed to accept 200 ampere bushing inserts and shall have removable, silver-plated copper studs.

b) Bushings and bushing wells shall have interfaces in accordance with ANSI/IEEE Standard 386 (ANSI Standard C119.2) to accept all standard separable insulated connectors and inserts. Parking stands are provided adjacent to each bushing and bushing well to accommodate horizontal feed-throughs and standoff insulators.

c) Fuse access panels shall have a mechanical interlock that guards against gaining access to the fuse before opening the load-break separable insulated connector at the fuse terminal.

d) The fuse shall be accessible only when de-energized and isolated — for full-view no-loadbreak disconnection and removal with a shotgun stick. This mounting features positive latching in both the energized and de-energized positions. When latched in the open position, the de-energized fuse is electrically isolated and readily accessible to operating personnel for removal with full visibility of contact interfaces on both sides of the fuse.

e) Access to the compartment containing energized components when fuses are being changed shall be blocked by a GPO-3 panel that is secured in position.

f) Individual parking stands shall be provided for each fuse mounting to allow convenient installation of elbow accessories to accommodate grounding. A ground rod shall be installed across the full width of the fuse compartments for connecting of cable concentric neutrals. Fuse phases shall be equipped with cable guides to assist in cable training and to prevent cables from interfering with movement of the fuse-access panel.

g) To provide maximum service life and to prevent corrosion of moving parts, all latches and pivots in the fuse-handling mechanism shall be either painted steel, stainless steel, or zinc-plated.

The following optional features may be specified:

h) Fuse storage hooks shall be provided on fuse-termination compartment access door(s). Each set of hooks shall allow the storing of three complete fuse assemblies for power fuses. Storage hooks shall be for two holders when current-limiting fuses are used.

4. Switch Operators for Remote-Supervisory Control

a) Switch-operators for remote-supervisory control shall be provided to operate the high-voltage source interrupter switches. They shall be motor charged to trip-open and trip-close the switches.

b) Switch operators shall charge and trip a quick-make quick-break mechanism on the switch installed by the switch manufacturer, and shall have sufficient mechanical energy to open or close the associated interrupter switch.
The quick-make quick-break mechanism shall swiftly and positively open and close the interrupter switch independent of the speed of the charging motor or manual handle.

c) Switch operators shall charge and trip the associated source interrupter switch in response to a remote control signal.

d) Pushbuttons shall be provided to permit local electrical trip-open and trip-closed operation. Local pushbutton electrical operation shall be prevented when the operator is in the remote mode.

e) Switch operators shall be provided with a charging shaft and a removable manual handle to allow manual charging and tripping of the quick-make quick-break mechanism in the event control power is lost.

f) Switch operators shall be located in a grounded, steel-enclosed low-voltage compartment. The compartment shall provide complete isolation from high voltage to help protect operating personnel.

g) Switch operators shall be equipped with indicators to show whether the associated source interrupter switch is in the open or closed position.

h) Switch operators shall be provided with a decoupling feature to permit decoupling of the operator from the associated interrupter switch for testing and exercising of the switch operator and controls without opening or closing the interrupter switch and without exposure to high voltage.

i) When the switch operator is decoupled, the associated interrupter switch shall be locked in the position it was in at the time of decoupling. It shall not be possible to recouple the switch operator to the source interrupter switch unless the switch operator is in the same position (open or closed) as the interrupter switch.

The following optional feature can be selected:

j) Switch operators shall be provided with an extra 4-PST auxiliary switch coupled to the source interrupter switch.

5. Interface For Remote Operation
   a) Interface Connections
      1) The switch operator shall provide for interfacing with a remote-terminal unit (RTU). The RTU shall be provided and installed by the user or may be optionally provided and installed by the supplier of the pad-mounted switchgear, or provided by the user and installed by the switchgear supplier, as designated in the user’s specification.
      2) The interface shall include terminal points for connection to the RTU that allow for determination of whether the switch is in the open position or in the closed position.
      3) The interface shall include terminal points for connection to the RTU that allow for determination of whether the battery (if so equipped) is providing adequate voltage for operating the system.
      4) The interface shall include terminal points for connection to the RTU that allow for remote operation of the switch operator to open and close the switch when coupled.
      5) The interface shall include terminal points for connection to the RTU that allow for remote indication of the status of the Local/Remote Selector Switch (if furnished) — either in the LOCAL or REMOTE position.
   b) Control Features
      1) A Local/Remote Selector Switch shall be furnished for choosing operating mode. In the “local” mode, electrical trip-open and trip-closed operation by means of pushbuttons shall be enabled while remote switching shall be inhibited.
      2) The battery and battery charger, if furnished, shall be located in a grounded, steel-enclosed low-voltage compartment. The control compartments shall provide isolation from high voltage.

The following optional features can be selected:

3) Light-emitting lamps shall be furnished for indicating the presence of acceptable voltage on the high-voltage source.

4) Separate light-emitting lamps shall be furnished for indicating the switch positions and the control operating mode (Local/Remote).

c) Voltage Sensing and Control Power
   1) Voltage sensing and control power input shall be provided by one or more voltage transformers on the load side of the source interrupter switch.
   2) The output of the voltage transformers shall be directly proportional to line-to-ground voltage and shall have accuracy over an ambient temperature range suitable for the application.
   3) Constant current devices vulnerable to being opened or shorted are not to be used to provide voltage sensing or power for operation.

d) Current Sensing
   1) Current sensing shall be provided to detect the level of load current as well as for fault detection and measurement. The feature shall include a light-emitting lamp for indicating when a fault condition has occurred, a reset button for manually resetting the overcurrent condition, and three current sensing devices for each source.
   2) Provisions shall be furnished for manually resetting the overcurrent condition from a remote location.

The following optional features can be selected:

e) Voltage Sensing
   Three-phase voltage sensing shall be provided. Voltage sensing devices for three-phase sensing shall be furnished on phases where voltage transformers are not utilized.

f) Remote Indication
   Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence of source voltage and the operating mode - Local/Remote.

g) Supervisory Control
   Supervisory control provisions shall be provided to permit switch operation from a remote location.
E. Labeling

1. Warning Signs
   a) Each external door providing access to high voltage shall be provided with a suitable hazard-alerting sign.
   
   b) The inside of each door providing access to high voltage shall be provided with a “Danger-High Voltage — Keep Out — Qualified Persons Only” sign.
   
   c) Any barrier used to prevent access to energized live parts shall be provided with a “Danger-High Voltage—Keep Out—Qualified Persons Only” sign on both sides.

2. Nameplate, Ratings Labels, & Connection Diagrams
   a) The outside of both the front and back shall be provided with nameplates indicating the manufacturer’s name, catalog number, model number, and date of manufacture.
   
   b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings, including duty-cycle fault-closing capability and amperes, short-time, RMS (momentary asymmetrical and one-second symmetrical).
   
   c) A three-line connection diagram showing interrupter switches, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, inside the door of each motor operator, and on the inside of each switch operating hub access cover.

F. Accessories

1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.

2. A fuse handling tool (for use on a customer furnished hotstick) as recommended by the fuse manufacturer shall be furnished.

3. Grounding elbows as recommended by the switchgear purchaser.
Federal Pacific of Bristol, Virginia offers Live-Front and Dead-Front Automatic Source Transfer Pad-Mounted Switchgear for those applications where alternate sources of power are essential for continued operation of critical loads. This switchgear features the Federal Pacific Automatic-Transfer Software Program in the SEL-451 Relay to monitor the system conditions. The relay automatically initiates transfer to an alternate power source if voltage on the normal source reduces below a preset level. Federal Pacific Type PM motor operators activate opening and closing of the Federal Pacific Auto-jet®II Load-Interrupter Switches and complete an automatic source-transfer operation in approximately eight (8) seconds or, in an optional arrangement, as fast as 25-29 cycles.

Federal Pacific automatic-transfer pad-mounted switchgear provides automatic two-way source transfer with the ability to connect either of the two utility sources (or a utility source and a standby generator) to the switchgear bus. In automatic transfer switchgear, one incoming line switch is closed (preferred source) and the other incoming line switch is open (alternate source).

The Federal Pacific automatic control monitors the condition of both power sources and initiates automatic switching when preferred-source voltage drops below a preset level for a selected length of time (field selectable) that is sufficient to establish that the voltage drop is not transitory. The switch connected to the preferred source automatically opens and the switch connected to the alternate source automatically closes, restoring power to the load.

Federal Pacific Automatic-Transfer Pad-Mounted Switchgear utilizes a state-of-the-art electronic relay to perform control operations that are directed by settings programmed into the device at the factory and in the field. Such parametric characteristics as voltage-, current- and time-related operating parameters are entered into the relay by means of a laptop computer. The entries are readily viewed on the laptop computer. Internal memory with back-up battery records events and maintains a log, allowing diagnostic capability.

Field Selectable Functions
To simplify entry of this information and to permit its quick review on the laptop computer, the field-selectable functions are grouped in the “MM Transfer Settings” screen, which is accessed through the software program supplied with the switchgear. The applicable pull-down screen in the software is illustrated in Figure 2.
The field-selectable functions are:

CT Ratios for Source 1 and Source 2

PT Ratios for Source 1 and Source 2

Over-Current Enabled — Y = Enabled; N = Disabled — Over-current Lockout Is enabled or disabled

Over-Current Level for Source 1 and Source 2 — current level above which an over-current condition exists

Over-Current Lockout Timer (seconds) — time the over-current exists before declaring an over-current lockout

Source 1 Initial Transfer Delay timer (seconds) — time after dead source is declared before a transfer is initiated when Source 1 is the preferred source

Source 1 Return Transfer Delay timer (seconds) — time after return of source voltage before a retransfer to the preferred source is initiated when Source 1 is the preferred source and Auto Retransfer is enabled

Source 2 Initial Transfer Delay timer (seconds) — time after dead source is declared before a transfer is initiated when Source 2 is the preferred source

Source 2 Return Transfer Delay timer (seconds) — time after return of source voltage before a retransfer to the preferred source is initiated when Source 2 is the preferred source and Auto Retransfer is enabled

Generator as Alternate — Y = yes and N = no — apply Y when alternate source is a generator; otherwise apply N

Source Paralleling — Y = yes and N = no — apply Y when paralleling sources on Return Transfer is permitted; otherwise apply N

Return Transfer Sequence (Open or Closed) — select open or closed transition return on retransfer to the preferred source

CDT (seconds) — Generator Cool Down Timer (applicable only when the alternate source is a generator)

Generator Stop Pulse Duration (seconds) — Time that the generator stop contact will remain closed

Auto Retransfer (Y = Enabled, N = Hold for retransfer) — select automatic return on retransfer to the preferred source or hold return on retransfer to the preferred source

Dead Source Voltage (volts) — phase-to-neutral primary voltage required to declare a dead source

Live Source Voltage (volts) — phase-to-neutral primary voltage required to declare a live source

Voltage Unbalance (volts) — Zero sequence voltage required to declare a voltage unbalance bad source (designated as 3VO)

Functional Status LEDs

Additional functional status conditions for both sources are indicated by twenty-four (24) available illuminated LEDs with labels on the faceplate of the relay.

These LEDs provide indications as follows:

Over-Current Suspend — Illuminates when an over-current has occurred and resets off if there is no loss of source voltage

Over-Current Lockout — Illuminates when an over-current occurs that is followed by a loss-of-source voltage

M1 Decouple — Motor 1 is decoupled — Capability displays for Motor 1 whether the mechanism is decoupled from the switch (LED illuminated) or coupled (LED not illuminated) to the associated switch

M1 No Go — LED is illuminated when Motor 1 has malfunctioned; otherwise LED is not illuminated

M1 Batt/Chg — Motor 1 Battery or Battery Charger has malfunctioned — LED is illuminated when Motor 1 battery or battery charger has malfunctioned; otherwise LED is not illuminated

M1 Cls/Opn — Motor 1 is Closed or Open — LED is illuminated green when Motor 1 is open; illuminated red when Motor 1 is closed

M1 Rem/Lcl — Motor 1 is in Remote or Local — LED is illuminated when Motor 1 is in remote; otherwise LED is not illuminated

M2 Decouple — Motor 2 is decoupled — Capability displays for Motor 2 whether the mechanism is decoupled from the switch (LED illuminated) or coupled (LED not illuminated) to the associated switch

M2 No Go — Motor 2 has malfunctioned — LED is illuminated when Motor 2 has malfunctioned; otherwise LED is not illuminated

Figure 3. Twenty-four Status LEDs are provided to give actual status of key functions. The various LEDs and the associated functions are illustrated above. In addition, the "ENABLED" LED provides indication that the SEL-451 relay is powered on and the "TRIP" LED illuminates when the relay has initiated a transfer operation.
M2 Batt/Chg — Motor 2 Battery or Battery Charger has malfunctioned — LED is illuminated when Motor 2 Battery or Battery Charger has malfunctioned; otherwise LED is not illuminated

M2Cls/Opn — Motor 2 is Closed or Open — LED is illuminated green when Motor 2 is open; illuminated red when Motor 2 is closed

M2 Rem/Lcl — Motor 2 is in Remote or Local — LED is illuminated when Motor 2 is in remote; otherwise LED is not illuminated

Mismatch — Motor 1 and Source Switch 1 or Motor 2 and Source Switch 2 are not in the same positions — LED is illuminated when Motor 2 is in remote; otherwise LED is not illuminated

S1VA, S1VB and, S1VC — illumination of the LED establishes for the applicable Source 1 phase whether the associated source voltage is available (above minimum conditions) or, if the LED is not illuminated, that source voltage is not available (below minimum conditions) on the associated phase

S2VA, S2VB and, S2VC — illumination of the LED establishes for the applicable Source 2 phase whether the associated source voltage is available (above minimum conditions) or, if the LED is not illuminated, that source voltage is not available (below minimum conditions) on the associated phase

Interactive Soft Keys

A grouping of twelve (12) interactive soft keys combined with status LEDs and labels allow surface selection and actuation of a number of operating choices.

The interactive soft keys that provide Local Operation capability on the faceplate of the SEL-451 relay include:

Open/Close keys for each source switch — Capability allows actual open and close operations of the associated switch and also illuminates an LED to display for each source the actual switch position (“Switch Open” — green or “Switch Closed” — red) of the associated switch.

Auto or Manual operation selection — establishes operating mode of the relay — actual mode is set by depressing the applicable soft key and status is indicated by illumination of the LED that is adjacent to the two soft keys labeled “Auto” and “Manual” in a green color, designating the present mode

Source 1 or Source 2 selected as the preferred source — capability for each source switch to provide service as the “Preferred” source, which provides power to the load under normal conditions, or as the “Alternate” source, which provides power to the load when the preferred source is not available.

Hold Return — Return to preferred source — if the “Auto Retransfer” MM Setting is disabled

Remote Enabled — capability for units furnished with SCADA interface to position the control in “Enabled” or “ Disabled” mode. The control is by default in “Disabled” mode and can only be placed in “Enabled” mode through user positioning the interactive soft key on the faceplate of the relay as indicated by illumination of the associated LED

Reset Over-Current Lockout — allows reset of the over-current lockout condition touch the labeled soft key to reset the control following an overcurrent lockout condition. The associated LED is flashing red when an overcurrent lockout condition exists.

Generator Start/Stop — enabled if the alternate source is a generator

LCD Display

A large LCD display on the faceplate of the relay will continuously and automatically scroll through ten (10) primary display points. The primary display points include functions as follows:
Phase Currents for Source 1 and Source 2
Phase Voltages for Source 1 and Source 2
Mismatch for Motor 1 and Motor 2 — shows whether the motor and the switch are in the same position to permit coupling
UPS Battery Voltage — status of battery voltage (adequate or low)
Battery Charger — Status of AC input to the battery charger
Faulted Phase — Identification of the phase on which a fault has occurred
Permissive Generator Start — Status of start key if the alternate source is a generator

The LCD display also supports a Main Menu screen that allows access to:

EVENTS Log — provides date/time stamp on events and current/voltage at time of event
SET/SHOW — Function provides the facility to edit the DATE/TIME
DISPLAY TEST — Function provides the facility to perform a lamp test of all the LEDs to verify functionality of all LEDs

Figure 6. Faceplates and features of the SEL-451 relay and the UPS are illustrated above and each is identified by a numbered callout.

1. Front Serial Port
2. LCD Screen
3. ESC – Escape Key
4. Enter Key
5. Navigation Soft Keys for LCD Screen
6. Trip LED Indicating Lamp
7. Enabled LED Indicating Lamp
8. Status Indicating Lamp
9. Status-Indicating-Lamp Functional Description
10. Target Reset Soft Key
11. Actuation Soft Key to Change Status Condition (typical)
12. LED Indicating Lamp for Status Condition (typical)
13. Status Condition Label (typical)
14. Screws (4) Secure Battery in Position
15. Battery Pullout Handle Grip
16. Battery Compartment
17. Test Switch - To Simulate Over-current with Voltage Loss (i.e. Lockout Mode)
18. Test Switch - To Simulate Source 2 Voltage Loss
19. Test Switch - To Simulate Source 1 Voltage Loss
20. Generator Start/Run Permissive On/Off Selector Switch
21. Duplex Receptacle Outlet - Allows outlet for laptop computer (5 amp fuse)
22. Fuse for Battery-Charger Circuit
23. Battery-Charger Pullout Handle Grip
24. Battery-Charger Power Status Indicating Lamps (IN and OUT)
25. Battery-Charging and Battery-Charger-Fuse Status Indicating Lamps
26. Access Port to Activate UPS Battery to Power Up Relay
Automatic Source-Transfer Applications

The Federal Pacific Type PM Run-and-Trip and Fast-Trip motor operators will also be the primary devices to affect switching operations in automatic source-transfer applications for Federal Pacific Automatic-Transfer Pad-Mounted Switchgear. Each switch in the source-transfer scheme will be automated using either the run-and-trip motor operator or, optionally, the fast-trip motor operator. The control providing the intelligence for automatic switching operations will be the SEL-451 relay that includes revolutionary software developed for Federal Pacific Automatic-Transfer Pad-Mounted Switchgear.

In automatic source-transfer applications, the motor operators charge the spring of the associated Auto-jet®II switch and synchronously effect a transfer operation from one (preferred) source to the second (alternate) source following loss-of-source voltage (or reduction of voltage below a predetermined, field selectable level) on the preferred source. Switching functions are all pre-programmed and controlled by the SEL-451 relay and many functions are field selectable as described under "Field Selectable Functions" on page 61.

Run-and-Trip motor operators are employed in automatic-transfer applications where speed of operation is not a significant consideration. Fast-Trip motor operators are employed in automatic-transfer applications where speed of operation may be a mandated requirement, such as in hospital or in process-industry facilities.

There are two transfer times of technical significance: (a) 1/4 cycle (5 milliseconds) and (b) 2 cycles (33 milliseconds). For the former, transfer operations in 1/4 cycle allow computers and relay circuits to remain intact without losing power. For the latter, transfer operations in 2 cycles will allow metal halide lamps to remain illuminated, keeping stadium and arena lights on. Beyond these two extremely short time duration requirements, speed of operation is not a significant application consideration; therefore, motor operators effecting a transfer operation in as fast as 10-cycles, which does not include the typically required 1/4 second minimum time delay to establish that an outage is extended, is of little advantage over one that effects a transfer operation in a few seconds, such as the Federal Pacific run-and-trip motor operator (see Figure 7) or even as fast as the 25-29 cycles capability provided with the Federal Pacific Fast-Trip motor operator (see Figure 8). Consequently, run-and-trip motor operators are more than adequate for the vast majority of automatic-transfer operations. Operating time for the Federal Pacific automatic source-transfer scheme using run-and-trip motor operators is approximately eight (8) seconds. For applications requiring transfer to occur in less than one second, Federal Pacific has developed the Fast-Trip motor operator for which the operating time from the instant the first switch starts to move until the closing of the second switch is approximately 25-29 cycles.

Figure 7. The Federal Pacific Run-and-Trip motor operator, as illustrated above, provides automation for Federal Pacific Auto-jet® II load-interrupter switches. Federal Pacific motor operators have the reliability essential to providing power to critical loads. These motor operators include a long-life battery and battery charger to insure functionality even when the control-power source is not available.

Figure 8. The Fast-Trip Motor Operator is illustrated above with the interlocked cover over the motor shown closed in the photo at left and with the cover open in the photo at right. As the motor rotates at high speed, if the cover is open motor operation is suspended. A separate key interlock (see arrow in photo) can be provided to block operation of the motor operator for other specific requirements, such as requiring that all switches be open before allowing access to fuses.
Auxiliary Components & Capabilities

The Federal Pacific automatic-transfer scheme includes a UPS (uninterruptable power supply), test function capabilities and an electrical outlet. The UPS provides adequate battery backup for the SEL-451 relay when control power has been lost regardless of cause. The UPS insures that the relay is always capable of performing its intended function whether or not the normal control-power source, the voltage transformers, is available. The UPS also includes a battery charger and associated alarm circuits (a) in the event AC Input to the battery charger is diminished or lost and (b) output from the battery is diminished below acceptable levels or lost.

The test function allows testing of the automatic-transfer scheme and of the over-current lockout system. These tests can be performed without actually opening and closing switches, which is made possible by the decoupling feature on the Federal Pacific motor operators. Pushbuttons are provided to allow (1) Simulating Lost of Voltage on Source 1, (2) Simulating Loss of Voltage on Source 2, and (3) Simulating an Overcurrent with a Loss of Source Voltage. These test functions exercise the automatic transfer capability and when motors are coupled to switches will affect an actual transfer that will result in the loss of source voltage to the load or when the motors are decoupled from the associated switches will simulate a transfer that will not result in the loss of source voltage to the load.

The electrical outlet is provided to supply power for a laptop computer or other similar load. A duplex outlet is provided and the circuit is fused at 5 amperes. Consequently, the circuit is NOT adequate for power tools of any type.

Figure 9. The Federal Pacific automatic-transfer scheme includes a UPS (at top in photo), test pushbuttons to simulate loss of source voltage and over-current lockout to allow verification of the functionality of the transfer scheme, and a duplex outlet for connection of a laptop computer.
A. General

1. Product
The pad-mounted switchgear shall be Live-Front/ATPSI/II design as manufactured by Federal Pacific and shall conform to the following specification.

2. Assembly
The pad-mounted switchgear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, including sensing, controls, and control power supply, all completely factory-assembled and operationally checked.

3. Ratings
a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below: (Select 15kV or 25kV sets of ratings from the tables below)

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>15kV</th>
<th>25kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV, Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>kV, Maximum Design</td>
<td>17.5</td>
<td>27†</td>
</tr>
<tr>
<td>kV, BIL</td>
<td>95</td>
<td>125</td>
</tr>
<tr>
<td>Main Bus Continuous, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

Switch Short-Circuit Ratings

<table>
<thead>
<tr>
<th>Amps, RMS Symmetrical</th>
<th>Standard</th>
<th>14,000</th>
<th>12,500</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA, 3-Phase Symmetrical at Rated Nominal Voltage</td>
<td>HFC</td>
<td>25,000</td>
<td>25,000</td>
</tr>
<tr>
<td>Fault-Closing Amps, RMS, Asym., 3-Time Duty-Cycle</td>
<td>Standard</td>
<td>350</td>
<td>540</td>
</tr>
<tr>
<td>HFC</td>
<td>620</td>
<td>1,080</td>
<td></td>
</tr>
<tr>
<td>40,000</td>
<td>40,000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses with integral load-interrupters shall equal or exceed the short-circuit ratings of the pad-mounted switchgear.

4. Certification of Ratings:
The manufacturer shall be completely and solely responsible for the performance of the basic switch components as well as the complete integrated assembly as rated.

The manufacturer shall furnish, upon request, certification of ratings of the basic switch components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure.

5. Compliance with Standards & Codes
The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

a) All portions of ANSI C57.12.28, covering enclosure integrity for pad-mounted equipment.

b) Article 490.21(E) “Load Interrupters” in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

c) All preferred and optional ratings in IEEE C37.74 covering design and testing of the distribution switchgear, components and ways.

d) All portions of ANSI and IEEE standards applicable to the basic switch and fuse components.

6. Enclosure Design
a) To ensure a completely coordinated design, the pad-mounted switchgear shall be constructed in accordance with the minimum construction specifications of the
B. Construction - Assembly

1. Insulators

The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

a) Operating experience of at least 20 years under similar conditions.

b) Ablative action to ensure non-tracking properties.

c) Adequate leakage distance established by test per IEC Standard 60507.

d) Adequate strength for short-circuit stress established by test.

e) Conformance with applicable ANSI standards.

f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

g) Each insulator shall be x-rayed to assure it is essentially void free. An alternate testing method may be used only by approval of the engineer.

2. High-Voltage Bus

a) Bus and interconnections shall consist of bare aluminum bar with an oxide-inhibiting agent at all bus joints.

b) Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2" - 13 bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut or with a wide, flange-head carriage bolt and one Belleville spring washer under the nut per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e. 1-bolt and spring washer. Bolts shall be tightened to an appropriate foot-pounds torque.

d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

3. Ground-Connection Pads

a) A ground-connection pad shall be provided in each compartment of the pad-mounted gear.

b) The ground-connection pad shall be constructed of 1/4" thick stainless steel, which shall be welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

4. Low-Voltage Components

a) All low-voltage components, including motor operators and source-transfer control, shall be located in a grounded, steel-enclosed compartment separate from high voltage to provide isolation and shall be arranged to allow complete accessibility for test and/or maintenance without exposure to high voltage.

b) Low-voltage wiring, except for short lengths such as at terminal blocks and the secondaries of sensing devices, shall be shielded where necessary for isolation from high voltage.

C. Construction - Enclosure & Finish

1. Enclosure

a) The pad-mounted gear enclosure shall be of monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

b) Separate grounded, steel-enclosed or aluminum low-voltage control compartments shall be provided for the micro-processor control and motor operators.

c) The basic enclosure material shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet.

d) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth.

e) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally removable hardware that allows penetration inside the enclosure.

f) The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

g) The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry. Flange corners shall be welded and ground smooth unless formed without a seam.

h) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.

i) Flanges at door openings of the low-voltage control compartment shall be provided with resilient compression gasketing around the entire door opening, and shall provide strength and rigidity for effective compression of the gasketing to prevent water entry.

j) Enclosure top side edges shall overlap with roof side edges and create an interface which shall allow ventilation of high-voltage compartments to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
k) A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.

l) Insulating interphase and end barriers of NEMA GP0-3 grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings.

m) Full-length steel barriers shall separate side-by-side compartments and barriers of the same material shall separate the front compartments from the rear compartments.

n) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be an open mesh to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

o) A steel-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 24 inches and to accommodate sensing components.

p) A closed-cell gasketing material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.

q) Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gap when the switch is open. A window panel shall be provided to allow viewing of the switch position without removing the barriers. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

r) Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2). These barriers must not be left in the inserted position for more than one week.

s) To prevent moisture ingress, the roof shall be one-piece construction and shall not include any gasketed joints or any ungound weld butt joints exposed to the exterior.

2. Doors

a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.

b) Doors providing access to high-voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry. Flange corners shall be welded and ground smooth unless formed without a seam.

c) Doors providing access to the low-voltage control compartment shall have 90-degree flanges providing a deep overlap with the door openings. To keep low-voltage components clean and dry, these doors shall be gasketed.

d) Doors providing access to high voltage shall have a minimum of three hinges and doors providing access to low voltage components shall have a minimum of two hinges or continuous hinges. Door hinges shall be of stainless steel with stainless-steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless-steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

e) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage shall be equipped with an automatic three-point latching mechanism.

1) The latching mechanism shall be spring loaded and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.

2) A penta-head socket wrench or tool placed on a penta-head bolt shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.

3) The actuating penta-head bolt shall have a cover that is padlockable and shall not require excessive force to turn.

4) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches.

i) It shall not be possible to access the penta-head actuator until the padlock is removed.

ii) It shall not be possible to unlatch the mechanism until the padlock is removed.

iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.

iv) All moving parts of the latches and all latch springs and bushings shall be of stainless steel.

f) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units in a galvanized steel compartment.

g) Each door shall be provided with a door holder of stainless steel with stainless-steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless-steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

3. Ventilation Openings

a) Each vent shall have an inside screen and baffle to protect against insertion of foreign objects and entry of insects.

b) Screened ventilation openings shall be provided in the bottom of the low-voltage compartments.

The following optional features may be specified:

h) If specified, an optional storage arrangement accommodating three complete fuse assemblies shall be provided on each fuse-compartment door.

The following optional features may be specified:

3) If specified, rain-resistant vents shall be provided on the enclosure to provide increased ventilation of high-voltage compartments.
4. Finish

a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components, such as doors and roofs, before assembly into the unitized structures.

b) All exterior seams shall be sanded or ground smooth for neat appearance.

c) All surfaces shall undergo a chemical cleaning, phosphating or zirconization and sealing process before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs for a pleasing appearance.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7GY 3.29/1.5, dark green.

h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide, on request, certification that representative test panels, protected by the manufacturer’s finish system or have passed the coating system performance requirements in section 5.5 of ANSI C57.12.28 as verified by an independent third party certifier, such as UL®.

i) To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc chromate plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Peak currents shall be consistent with the requirements of IEEE standard C37.74. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be operated by means of motor operators installed by the switch manufacturer.

c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

d) Interrupter switches shall be provided with a single-arm blade construction, with parallel current paths for each phase, and with contacts for circuit closing including fault-closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades that can be out of sequence with a main blade shall not be permitted.

e) Interrupter switch-blade supports shall be permanently fixed in place in a unified hinge-contact assembly, utilizing a louvered contact configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during momentary currents.

f) Switch-blade hinge contacts that have wiping contacts directly connected to switch terminals and can be pulled apart by cable connected to the switch terminals are specifically prohibited, such designs can present potential arcing faults if cables are pulled.

g) Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place within the interrupter with essentially no external arc or flame.

h) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time.

i) To further ensure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to ensure arc extinction.

j) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.

k) Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

The following optional features may be specified:

l) Bracket-mounted distribution-class surge arresters, metal-oxide type (specify rating), shall be provided at all source switch terminals.

m) Switch terminals shall be provided with adapters to accommodate two cables per phase.

n) Mounting provisions shall be provided to accommodate either one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment and (with or without, select one) a viewing window in the door, or an LED-Type fault indicator with 5/16” diameter hole on each switch-compartment door with each hole plugged for shipment using a system of tamper-resistance hardware.

o) Mounting provisions to accommodate LED-Type fault indicators. Holes for such fault indicators shall be plugged with a tamper-resistant arrangement for shipment.

2. Fuses

a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

b) Fuse-mounting jaw contacts shall incorporate an integral load-interrupter that shall permit live switching of fuses with a hookstick.
1) The integral load-interrupter housing shall be of the same cycloaliphatic epoxy resin as the insulators.

2) The integral load-interrupter shall be in the current path continuously during circuit interruption. Auxiliary blades or linkages shall not be used.

3) Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.

4) The integral load-interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation and to meet frequent switching requirements.

5) Internal moving contacts of the integral load-interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.

6) Circuit interruption shall take place completely within the integral load-interrupter with essentially no external arc or flame.

7) The integral load-interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault-currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.

8) Integral load-interrupters for fuses shall have a three-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse at 14.4kV or 25kV and have other ratings consistent with the preferred ratings in IEEE C37.74. The duty-cycle fault-closing capability defines the level of available fault-current into which the fuse can be closed three-times without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load-interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

9) To assist operator identification, the integral load-interrupter shall have a positive latch indicator that shall present a visible target to show that the fuse is completely latched closed and ready for the next opening operation.

10) To increase contact separation speed, interrupter contacts shall be spring assisted to retract and thereby reduce arcing time.

11) To further insure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on contact travel to insure arc extinction.

12) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.

13) Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.

14) Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

The following optional feature may be specified:

c) Fuse storage hooks shall be provided on the inside of each fuse-termination compartment door. These hooks shall accommodate a complete fuse assembly consisting of a fuse holder with fuse units or end fittings with silencer plus the fuse unit. Fuse storage provisions shall not be inside switch termination-compartment doors.

3. Motor Operators

a) The motor operators shall be provided to operate the high-voltage source-interrupter switches. They shall be run-and-trip, which charges and trips the switch quick-make quick-break mechanism when operation is initiated.

b) The motor operators shall charge and trip the switch, which has an integral quick-make quick-break mechanism installed by the switch manufacturer, and shall have sufficient mechanical energy to open or close the associated interrupter switch. The quick-make quick-break mechanism shall swiftly and positively open and close the source-interrupter switch independent of the speed of the charging motor or manual crank handle.

c) The motor operators shall charge and trip the mechanism to release the stored energy to open or close the associated source-interrupter switch in response to a control signal.

d) The motor operators shall be equipped with a motor that shall charge the quick-make quick-break mechanism, even when voltage is present on only one source.

e) Toggle switches or pushbuttons shall be provided to permit local electrical trip-open and trip-closed operation. Local toggle switch or pushbutton electrical operation shall be prevented when the control is in the automatic mode.

f) The motor operators shall be provided with a charging shaft and a removable manual crank handle to allow manual charging and tripping of the quick-make quick-break mechanism in the event that control power is lost.

g) The motor operators shall be located in grounded, aluminum low-voltage control compartments. The control compartments shall provide complete isolation from high-voltage to help protect operating personnel.

h) There shall be indication to show if the mechanism is coupled or decoupled, if the associated source-interrupter switch is in the open or closed position, and if the motor operator is in the switch-open or switch-closed position.

i) There shall be an operation counter provided for each motor operator and each switch to show the number of operations that have been performed.

j) The motor operators shall be provided with a decoupling feature to permit decoupling of the motor operator output shaft from the associated source-interrupter switch for testing and exercising of the motor operator and micro-processor control without opening or closing the interrupter switch and without exposure to high voltage. A tool other than the manual crank handle shall not be required for decoupling or coupling the switch and switch operator. An indicator label shall be provided to show whether the operator is coupled or decoupled.
k) When the motor operator is decoupled, the associated source-interrupter switch shall be locked in the position it was in at the time of decoupling. It shall not be possible to couple the motor operator to the source-interrupter switch unless the motor operator is in the same position (open or closed) as the source-interrupter switch.

l) Electrical functionality of the transfer system shall be enabled only when both motor operators are either coupled to or decoupled from their associated switch. Electrical functionality of the transfer system shall be disabled when one motor operator is coupled and the other motor operator is decoupled.

m) The motor operator shall be provided with visual indication in order to establish the condition of the motor operator as either open or closed.

The following optional feature may be specified:

n) The motor operators shall be provided with an extra 4-PST auxiliary switch coupled to each source-interrupter switch.

o) The motor operators shall be provided with an extra 4-PST auxiliary switch coupled to each operator mechanism.

p) The motor operators shall be fast-trip style, which charges and trips the switch mechanism in approximately 18-19 cycles after operation is initiated. As a result, a complete transfer operation (one switch opening and the other switch closing) can be accomplished in 25-29 cycles.

4. Control for Automatic Transfer

a) Operating Description

1) Transfer on Loss and Return of Source Voltage

i) The control relay shall be the SEL-451 relay and shall utilize the common-bus primary-selective system. The normal condition shall be with one source-interrupter switch (for the preferred source) closed to energize the high-voltage bus and with the other source-interrupter switch (for the alternate source) open with its associated power source available as a standby. The control in AUTO shall monitor the conditions of both power sources and shall initiate automatic switching when the preferred-source voltage has been lost (or reduced to a predetermined field-selectable level) for a period of time (field selectable) sufficient to confirm that the loss is not transient. Automatic switching shall open the preferred-source-interrupter switch and then close the alternate-source-interrupter switch to restore power to the high-voltage bus.

ii) When normal voltage returns to the preferred source for a field-selectable preset time, the control shall initiate re-transfer to the preferred source if in the Auto Retransfer function is enabled, or await manual re-transfer if the Auto Retransfer function is disabled. When the Auto Retransfer function is disabled and if the alternate source fails and the preferred source has been restored, the control relay shall override the hold function and initiate an Auto Retransfer to the preferred source.

iii) In the Auto Retransfer enabled mode, the control relay shall provide field selectivity of either Source Paralleling enabled (closed transition return) or Source Paralleling disabled (open transition) on re-transfer.

2) Transfer on Unbalance Condition

i) An unbalance detection feature with a field selectable voltage level shall initiate automatic switching on detection of source-side open-phase conditions at the same system voltage level as the pad-mounted gear, whether caused by utility-line burned down, broken conductors, single-phase switching, equipment malfunctions, or single-phasing resulting from blown source-side fuses. The control relay shall continuously monitor the voltage to detect any based on a zero-sequence voltage unbalance present as a result of an open-phase condition. Automatic switching shall occur when the system unbalance-detect voltage is present for a period of time (field selectable) sufficient to confirm that the condition is not transient.

ii) If Auto Retransfer enabled has been selected when normal phase voltages return to the preferred source, the control shall initiate re-transfer to the preferred source as described in 4. (a) (i) (ii) and (iii).

b) Control Features

1) The operating characteristics of the control relay and its voltage-, current-, and time-related operating parameters shall be field programmable and entered into the control by a laptop computer. To simplify entry of this information, a listing of all the field selectable functions shall be included in a single MM Transfer Settings file with tabs to all navigation settings to allow changing the parameter setting using the laptop computer keyboard.

2) All operating characteristics and operating parameters shall be noted in instruction bulletins or otherwise available for review on the laptop computer.

3) The control relay shall have a large LCD screen to display the relay primary display points, which shall automatically scroll on the screen every five (5) seconds.

4) An LED with an appropriate label shall be furnished for indicating the presence of acceptable voltage on each phase of each high-voltage source.

5) A separate LED with an appropriate label shall be furnished for indicating the control relay operating mode (AUTO OR MANUAL) along with a soft key to allow direct selection of the applicable setting. In the manual mode, local electrical trip-open and trip-closed operation by means of pushbuttons shall be enabled while automatic switching shall be inhibited.

6) Separate LEDs shall be furnished for indicating the position of each switch.

7) Separate LEDs shall be furnished for indicating whether the motor operator is decoupled from the associated switch.

8) A separate test area shall be furnished with pushbuttons for simulating loss of voltage on each of the two sources.

9) A light-emitting lamp shall provide indication that the control relay is enabled and functioning properly.
10) The control relay shall provide for:
   i) Field selection by means of a laptop computer keypad of the timer setting that establishes
      the time delay between reduction of source voltage below the activation level and initiation
      of opening of the preferred source switch.
   ii) Field selection by means of a laptop computer keypad of the timer setting that establishes
       the time delay between return of source voltage to a value above the activation level and
       initiation of opening of the alternate source and reclosing of the preferred source.

11) The control relay shall incorporate an event log and shall have a LCD display to view settings and the
    event log entries.

12) The control relay shall allow for pushbutton selection of either source switch as the preferred
    source switch and shall provide an LED that illuminates to indicate the status

13) The control relay shall provide a pushbutton and LED to allow reset of the Hold Return condition
    and the pushbutton shall have to be pressed and held pressed for three (3) seconds before the
    Hold Return is deactivated and the switch will subsequently initiate an immediate return transfer
    to the preferred source. The return transfer shall either be open return or closed return depending on
    the field selectable setting that has been chosen.

14) The control relay shall provide a pushbutton and LED to allow activation of the Remote Enabled function.

15) The control relay shall provide an LED to Indicate that the motor operator are not in the same position
    (MISMATCH).

16) The control relay shall provide LEDs to indicate whether or not a motor operator Is in a NO GO
    condition.

17) The control relay shall provide an LED to indicate whether the control is in Remote or is in Local.

18) An uninterruptable power supply (UPS) shall be provided to provide power to the control relay when
    both sources are lost and there shall be an LED that illuminates when the battery or battery charger are
    not functioning properly.

c) Construction Features
   1) The control relay shall use components to provide the superior reliability required for use in power
      equipment. All components shall be selected to minimize the number of interconnections for
      increased reliability.
   2) The control shall be located either in the grounded, aluminum or steel-enclosed low-voltage
      compartment with a motor operator or in a separate low-voltage compartment. The control
      compartment shall provide isolation from high voltage.
   3) The control shall provide a ten (10) year warranty from the date of its manufacture.

d) Voltage Sensing and Control Power
   1) Voltage sensing and control power shall be provided by a combination of voltage sensors or by fused
      voltage transformers on the line side of each phase of the source-interrupter switches.
   2) The output of the voltage sensors or voltage transformers shall be directly proportional to system
      voltage and shall have accuracy over an ambient temperature range suitable for the application.
   3) Constant current devices vulnerable to being open circuited and requiring a protective device for such
      eventuality and shorting-type terminal blocks shall not be used to provide voltage sensing and power for
      operation.

The following optional features may be specified:

e) Overcurrent Lockout
   1) An over-current lockout feature shall be provided to prevent an automatic-transfer operation that
      would close a source-interrupter switch into a fault. The feature shall include a light-emitting
      lamp for indicating when a lockout condition has occurred, a reset key for manually resetting the
      lockout condition, and three current sensors for each source.
   2) Provisions shall be furnished for manually resetting the over-current lockout feature from a remote
      location.
   3) Test pushbutton shall be provided for simulating an over-current lockout condition on each source.

f) Remote Indication

Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence
of preferred- and alternate-source voltage as well as the operating mode of the source-transfer control (i.e.,
Auto or Manual).

g) Supervisory Control

Supervisory control provisions shall be provided to permit switch operation from a remote location.

E. Labeling

1. Warning Signs

a) All external doors providing access to high voltage shall be supplied with suitable hazard-alerting signs warning
   of the electrical hazard inside the compartments.

b) The inside of each door providing access to high voltage shall be supplied with a ‘Danger—High Voltage — Keep
   Out — Qualified Persons Only’ sign.

c) Both sides of each barrier providing access to an interrupter switch shall be supplied with a sign indicating that
   “Switch Blades May Be Energized in Any Position” on both sides.

d) Both sides of each barrier providing access to a fuse shall be supplied with a sign indicating that “Fuses May
   Be Energized in Any Position”.

e) Barriers used to slide into the open gap when switch or fuse is in the open position shall include a label indicating
   that the barrier should not be left in the slide-in position for more than one week.

f) An instruction label explaining correct operation of integral load interrupters for fuses shall be included on
   the inside of each door providing access to fuses.
2. Nameplate, Ratings Labels, & Connection Diagrams

a. The outside of both the front and rear doors shall be provided with nameplates indicating an equipment description, name of manufacturer and type designation, catalog number, model number, serial number and date of manufacture.

b. The inside of each door shall be provided with a ratings label indicating the following: voltage ratings including maximum voltage rating and BIL; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings — continuous and interrupting; and interrupter switch ratings, including duty-cycle fault closing capability and amperes, short-time, RMS (momentary asymmetrical and one-second symmetrical; the total weight; and a schematic diagram.

c. The schematic diagram shall be a three-line connection diagram showing interrupter switches, motor operators, current sensors (or current transformers), voltage transformers, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, inside the door of each motor operator, and on the inside of each switch operating hub access cover.

F. Accessories

The following optional features may be specified:

1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.

2. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

3. Grounding clamps as recommended by the end user.
A. General

1. Product

The pad-mounted switchgear shall be Dead-Front ATPSE design as manufactured by Federal Pacific and shall conform to the following specification.

2. Assembly

The pad-mounted switchgear shall consist of a single self-supporting enclosure, containing interrupter switches and power fuses with the necessary accessory components, including sensing, controls, and control power supply, all completely factory-assembled and operationally checked.

3. Ratings

a) Ratings for the integrated pad-mounted switchgear assembly shall be as designated below:

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>15kV</th>
<th>25kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV, Nominal</td>
<td>14.4</td>
<td>25</td>
</tr>
<tr>
<td>kV, Maximum Design</td>
<td>17.5</td>
<td>27+</td>
</tr>
<tr>
<td>kV, BIL</td>
<td>95</td>
<td>125</td>
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<tr>
<td>Main Bus Continuous, Amps</td>
<td>600</td>
<td>600</td>
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<tr>
<td>Switch Load-Interrupting, Amps</td>
<td>600</td>
<td>600</td>
</tr>
<tr>
<td>Switch Fuse Load-Interrupting, Amps</td>
<td>200</td>
<td>200</td>
</tr>
</tbody>
</table>

b) The momentary and three-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses shall equal or exceed the short circuit ratings of the pad-mounted switchgear.

STANDARD SPECIFICATION FOR DEAD-FRONT AUTOMATIC-TRANSFER PAD-MOUNTED SWITCHGEAR

Fuse Ratings

<table>
<thead>
<tr>
<th>Fuse Manufacturer</th>
<th>Fuse Type</th>
<th>Three-Phase MVA Sym.</th>
<th>Amps RMS Asym.</th>
<th>Cont. Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.4 kV Nominal Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;C</td>
<td>SM-4</td>
<td>310</td>
<td>20000</td>
<td>200</td>
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<tr>
<td>S&amp;C</td>
<td>SMU-20</td>
<td>350</td>
<td>22400</td>
<td>200</td>
</tr>
<tr>
<td>S&amp;C</td>
<td>SM-5 ‡</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
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<td>DBU</td>
<td>350</td>
<td>22400</td>
<td>200</td>
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<tr>
<td>Cooper</td>
<td>CMU</td>
<td>350</td>
<td>22400</td>
<td>200</td>
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<tr>
<td>Cooper (M-E) †</td>
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<td>620</td>
<td>40000</td>
<td>100*</td>
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<tr>
<td>Cooper (CT) †</td>
<td>X-Limiter</td>
<td>620</td>
<td>40000</td>
<td>140</td>
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<tr>
<td>Thomas &amp; Betts</td>
<td>Hi-Tech</td>
<td>620</td>
<td>40000</td>
<td>140</td>
</tr>
<tr>
<td>25 kV Nominal Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S&amp;C</td>
<td>SM-4 †</td>
<td>540</td>
<td>20000</td>
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<td>Cooper</td>
<td>CMU</td>
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<tr>
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<td>1080</td>
<td>40000</td>
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<tr>
<td>Cooper (CT) †</td>
<td>X-Limiter</td>
<td>1080</td>
<td>40000</td>
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</tr>
<tr>
<td>Thomas &amp; Betts</td>
<td>Hi-Tech</td>
<td>1080</td>
<td>40000</td>
<td>50</td>
</tr>
</tbody>
</table>

† Applicable to solidly-grounded neutral systems only with fuses connected by a single conductor concentric neutral type cable to a transformer or transformers. Rating is 9,400 amperes RMS symmetrical, 15,000 amperes RMS asymmetrical (405 MVA symmetrical) for all other applications.

‡ SM-5 fuses cannot be used in ATPSE Pad-Mounted Switchgear. Contact factory for SM-5 applications.

4. Certification of Ratings:

The manufacturer shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated pad-mounted switchgear assembly as rated.

The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted switchgear assembly consisting of the switch and fuse components in combination with the enclosure. This certification of the integrated unit shall include testing the pad-mounted switchgear to the fault-close requirements of the specification to assure the bus support system and components are adequate. Spacing between bus-support insulators in the unit furnished shall not exceed the spacing in the unit tested.
5. Compliance with Standards and Codes:

The pad-mounted switchgear shall conform to or exceed the applicable requirements of the following standards and codes:

a) Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970.
b) Article 490.21(E) "Load Interrupters" in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.
c) All portions of ANSI C57.12.28 covering enclosure integrity for pad-mounted equipment.
d) All portions of IEEE C37.74, including all preferred and optional ratings.
e) All portions of ANSI and IEEE standards applicable to the basic switch and fuse components.

6. Enclosure Design:

To ensure a completely coordinated design, the pad-mounted switchgear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access and tamper resistance.

B. Construction — Assembly

1. Insulators

The interrupter switch and fuse mounting insulators shall be cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

a) Operating experience of at least 15 years under similar conditions.
b) Ablative action to ensure non-tracking properties.
c) Adequate leakage distance established by test per IEC Standard 60507.
d) Adequate strength for short-circuit stress established by test.
e) Conformance with applicable ANSI/IEEE standards.
f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperature from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.
g) Each cycloaliphatic epoxy insulator, including bushings and bushing wells, shall be x-rayed to assure it is essentially void free. An alternate testing method may be used only by approval of the engineer.
h) Insulating operating arms, such as pushrods, not of a cycloaliphatic epoxy shall be of a non-hygroscopic material and must have 15 years exposure in environments subject to moisture ingress such as in pad-mounted switchgear installed over a cable pit subject to standing water for extended intervals

2. High-Voltage Bus:

a) Bus and interconnections shall consist of bare aluminum bar of 56% IACS conductivity with an oxide-inhibiting agent at all bus joints.
b) Bus and interconnections shall withstand the stresses associated with short circuits up through the maximum rating of the pad-mounted gear, including proper allowance for transient conditions.
c) Bolted aluminum-to-aluminum connections shall be made with a suitable number of non-corrosive bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to an appropriate torque to assure good electrical connection. As an alternate, aluminum-to-aluminum connections shall be made with a suitable equivalent surface area of an integrated and flanged carriage-bolt head and one Belleville washer (i.e. a one-piece carriage-bolt with spring washer).
d) Before installation of the bus, all electrical contact surfaces shall first be prepared by abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.
e) Where necessary, such as to achieve BIL or for enhanced isolation from the environment, the bus may be covered by a heat-shrink insulating material proven to be suitable for the voltage and the phase spacing involved.

The following optional feature may be specified:
f) Copper bus instead of aluminum bus

3. Ground Connections Pads:

a) A ground connection pad shall be provided in each termination compartment of the pad-mounted gear.
b) The ground-connection pad shall be constructed of galvanized steel or stainless steel 1/4” thick and have a NEMA 2-hole pattern for ground connections. The pad shall be welded to the enclosure and shall have a short-circuit rating equal to that of the integrated assembly.
c) A copper grounding rod, with each end bolted to the ground connection pad, shall be provided across the full width of each cable terminating compartment.

4. Low-Voltage Components

a) All low-voltage components, including motor operators and relays, shall be located in a grounded, steel-enclosed or aluminum compartment separate from high voltage to provide isolation and shall be arranged to allow complete accessibility for test and/or maintenance without exposure to high voltage.
b) Low-voltage wiring, except for short lengths such as at terminal blocks and the secondary of sensing devices, shall be shielded, where necessary, for isolation from high voltage.
C. Construction Enclosure and Finish

1. Enclosure:
   a) The pad-mounted enclosure shall be of unitized welded construction (not structural frame and bolted sheet) to maximize strength, minimize weight, and inhibit internal corrosion.
   b) Separate grounded, steel-enclosed or aluminum low-voltage control compartments shall be provided for the relay and motor operators.
   c) The basic pad-mounted enclosure materials shall be 11-gauge hot-rolled, pickled-and-oiled steel sheet. Enclosures of motor operators and micro-processor control may be of heavy-gauge aluminum sheet or steel.
   d) All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth.
   e) To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware that allows penetration inside the enclosure.
   f) The enclosure base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad. A closed-cell gasket material shall be placed on the bottom flange as a protective interface between the steel enclosure and the mounting pad.
   g) The enclosure door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry. Flange corners shall be welded and ground smooth unless formed without a seam.
   h) Three resilient material cushions shall be placed on door-opening edges to prevent metal-to-metal contact that would damage finish and lead to premature corrosion.
   i) Flanges at door openings of the low-voltage control compartment shall be provided with resilient compression gasket around the entire door opening, and shall provide strength and rigidity for effective compression of the gasket to prevent water entry.
   j) Enclosure top side edges shall overlap with roof side edges and a gasket shall be provided at the top flange around the high-voltage component compartment to isolate that section from environmental conditions.
   k) A heavy coat of insulating “no-drip” compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.
   l) Full-length steel barriers shall separate side-by-side termination compartments and barriers of the same material shall separate the termination compartments from the high-voltage compartments.
   m) Lifting tabs shall be removable and sockets for the lifting-tab bolts shall be blind-tapped. A resilient protective material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be open mesh to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.
   n) The enclosure shall provide space in the pad-mounted gear to accommodate sensors.

2. Barrier Assembly:

Insulating interphase and end barriers shall be of NEMA GPO-3 grade fiberglass-reinforced polyester and shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings.

3. Doors
   a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.
   b) Doors providing access to high voltage shall have door-edge flanges that shall overlap with door-opening flanges and shall be formed to create an interface that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the interior of termination compartments dry. Flange corners shall be welded and ground smooth unless formed without seams.
   c) Doors providing access to the low-voltage control compartment shall have 90-degree flanges providing a deep overlap with the door openings. To keep low-voltage components clean and dry, these door openings shall include gasket on all sides.
   d) Doors providing access to high voltage shall have a minimum of three hinges and doors providing access to low-voltage components shall have a minimum of two hinges or continuous hinges. Door hinges shall be of stainless steel with stainless-steel hinge pins to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-plated steel, and shall not be externally accessible to guard against tampering.
   e) In consideration of controlled access and tamper resistance, each set of double doors providing access to high voltage or termination compartments shall be equipped with an automatic three-point latching mechanism.

1) The latching mechanism shall be spring loaded and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.
2) A penta-head socket wrench or tool placed on a penta-head bolt shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
3) The acting penta-head bolt shall have a cover that is padlockable and the bolt shall not require excessive force to turn.
4) The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches.
   i) It shall not be possible to access the penta-head actuator until the padlock is removed.
   ii) It shall not be possible to unlatch the mechanism until the padlock is removed.
   iii) It shall not be possible to insert the padlock until the mechanism is completely latched closed.
iv) All moving parts of the latches and all latch springs and bushings shall be of stainless steel.

f) As an alternate, doors providing access to low-voltage components may be equipped with a padlockable door handle and a door holder at the bottom.

g) Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

h) Each door providing access to high voltage shall be provided with a door holder located above the door opening. The holder shall be of stainless steel and be hidden from view when the door is closed; it shall not be possible for the door holder to swing inside the enclosure.

The following optional feature may be specified:

i) If specified, an optional storage arrangement accommodating three complete fuse assemblies shall be provided on each fuse-compartment door. Fuse storage arrangements in the switch-termination compartments are not acceptable.

4. Ventilation Openings

a) A vent shall be provided in each corner of the floor plate in the high-voltage compartment. Each vent shall have an inside stainless steel screen to protect against entry of insects.

b) Screened ventilation openings shall be provided in the bottom of the low-voltage compartments.

The following optional feature may be specified:

c) If specified, rain-resistant vents shall be provided on the enclosure to provide increased ventilation of termination or high-voltage compartments as specified by the purchaser.

5. Finish

a) Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components, such as doors and roofs, before assembly into the unitized structures.

b) All exterior seams shall be sanded or ground smooth for neat appearance.

c) All surfaces shall undergo a chemical cleaning, phosphatizing, and sealing process before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.

d) The finishing system shall be applied without sags or runs.

e) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches.

f) Blemishes shall be carefully touched up by hand to restore the protective integrity of the finish.

g) Unless otherwise specified, the color shall be Munsell No. 7GY3.29/1.5, dark green.

h) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide on request, certification that representative test panels, protected by the manufacturer’s finish system, have passed the coating system performance requirements in ANSI C57.12.28-1999.

i) To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-chromate plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

D. Basic Components

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Peak currents shall be consistent with the requirements of IEEE standard C37.74. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be operated by means of motor operators installed by the switch manufacturer.

c) Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

d) Interrupter switches shall be provided with a single-arm blade construction, with parallel current paths for each phase, and with contacts for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades that can be out of sequence with a main blade shall not be permitted.

e) Interrupter switch-blade supports shall be permanently fixed in place in a unified hinge-contact assembly, utilizing a lowered contact band configuration that provides expansion and, therefore, increased pressure at the contact transfer point for a stable interface during high momentary and fault currents.

f) Circuit interruption shall be accomplished by use of an interrupter that is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place within the interrupter with essentially no external arc or flame.

g) To increase contact separation speed, interrupter switch contacts on both sides of the arcing area shall be spring assisted to reduce arcing time.

h) To further ensure arc extinction, air shall be compressed and simultaneously injected into the arcing area to cool the arc and thereby not rely solely on blade travel to ensure arc extinction.

i) Arc extinction shall not rely on gases generated by ablative action of the arc playing on any interrupter switch components or materials which will carbonize, deplete or otherwise erode such components and materials.
j) Switch terminals shall connect to 600 ampere bushings to accommodate 600 ampere elbows.

The following optional feature may be specified:

k) Mounting provisions shall be provided to accommodate either one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment and (with or without, select one) a viewing window in the door or an LED-Type fault indicator with 5/16" diameter hole on each switch-compartment door with each hole plugged for shipment using s system of tamper-resistant hardware.

l) Switch terminals shall connect to 200 ampere bushing wells to accommodate 200 ampere load-break elbows inserts (elbows and inserts not included). Bushing wells replace 600 ampere bushings.

m) An independent set of three (3) 200 ampere bushing wells (one per phase) shall be provided at each switch position with one bushing well positioned adjacent to each 600 ampere bushing. Accommodation of this set of 200 ampere bushing wells shall not require an increase in the height of the unit and shall be used to accommodate load-break inserts with grounding elbows or surge arresters (inserts, grounding elbows and surge arresters not included).

2. Fuses

a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

b) Fuse terminals shall incorporate 200 ampere load-break bushing wells.

The following optional feature may be specified:

c) Fuse storage hooks shall be provided on the inside of each fuse-termination compartment door. These hooks shall accommodate a complete fuse assembly consisting of a fuse holder with fuse units or end fittings with silencer plus the fuse unit. Fuse storage provisions shall not be inside switch termination-compartment doors.

3. Motor Operators

a) The motor operators shall be provided to operate the high-voltage source-interrupter switches. They shall be run-and-trip style, which charges and trips the switch quick-make quick-break mechanism in 8-12 seconds after operation is initiated. (Optional Fast-Trip Motor Operators are available see section below headed: “The following optional feature may be specified:"

b) The motor operators shall charge and trip the switch, which has an integral quick-make quick-break mechanism installed by the switch manufacturer, and shall have sufficient mechanical energy to open or close the associated interrupter switch. The quick-make quick-break mechanism shall swiftly and positively open and close the source-interrupter switch independent of the speed of the charging motor or manual crank handle.

c) The motor operators shall charge and trip the mechanism to release the stored energy to open or close the associated source-interrupter switch in response to a control signal.

d) The motor operators shall be equipped with a motor that shall charge the quick-make quick-break mechanism, even when voltage is present on only one source.

e) Toggle switches or pushbuttons shall be provided to permit local electrical trip-open and trip-closed operation. Local toggle switch or pushbutton electrical operation shall be prevented when the controlling relay is in the automatic mode.

f) The motor operators shall be provided with a charging shaft and a removable manual crank handle to allow manual charging and tripping of the quick-make quick-break mechanism in the event that control power is lost.

g) The motor operators shall be located in grounded, aluminum low-voltage control compartments. The control compartments shall provide complete isolation from high voltage to help protect operating personnel.

h) There shall be indication to show if the mechanism is coupled or decoupled, if the associated source-interrupter switch is in the open or closed position, and if the motor operator is in the switch-open or switch-closed position.

i) There shall be an operation counter provided for each motor operator to show the number of operations that have been performed by the motor.

j) The motor operators shall be provided with a decoupling feature to permit decoupling of the motor operator output shaft from the associated source-interrupter switch for testing and exercising of the motor operator and control relay without opening or closing the interrupter switch and without exposure to high voltage. A tool other than the manual crank handle shall not be required for decoupling or coupling the switch and switch operator.

k) When the motor operator is decoupled, the associated source-interrupter switch shall be locked in the position it was in at the time of decoupling. It shall not be possible to couple the motor operator to the source-interrupter switch unless the motor operator is in the same position (open or closed) as the source-interrupter switch.

l) Electrical functionality of the transfer system shall be enabled only when both motor operators are either coupled to or decoupled from their associated switch. Electrical functionality of the transfer system shall be disabled when one motor operator is coupled and the other motor operator is decoupled.

m) The motor operator shall be provided with visual indication in order to establish the condition of the motor operator as either open or closed.

The following optional feature may be specified:

n) Each source interrupter switch shall be provided with an extra 4-PST auxiliary switch coupled to the source-interrupter switch with a minimum of one contact pair available for customer connection.

o) The motor operators shall be provided with an extra 4-PST auxiliary switch coupled to each motor with a minimum of one contact pair available for customer connection.

p) The motor operators shall be fast-trip style, which charges and trips the switch mechanism in approximately 18-19 cycles after operation is initiated. As a result, a complete transfer operation (one switch opening and the other switch closing) can be accomplished in 25-29 cycles.
4. Control for Automatic Transfer

a) Operating Description

1) Transfer on Loss and Return of Source Voltage
   i) The control relay shall be the SEL-451 relay and shall utilize the common-bus primary-selective system. The normal condition shall be with one source-interrupter switch (for the preferred source) closed to energize the high-voltage bus and with the other source-interrupter switch (for the alternate source) open with its associated power source available as a standby. The control in AUTO shall monitor the conditions of both power sources and shall initiate automatic switching when the preferred-source voltage has been lost (or reduced to a predetermined field-selectable level) for a period of time (field selectable) sufficient to confirm that the loss is not transient. Automatic switching shall open the preferred-source-interrupter switch and then close the alternate-source-interrupter switch to restore power to the high-voltage bus.

   ii) When normal voltage returns to the preferred source for a field-selectable preset time, the control shall initiate re-transfer to the preferred source if the Auto Retransfer function is enabled, or await manual re-transfer if the Auto Retransfer function is disabled. When the Auto Retransfer function is disabled and if the alternate source fails and the preferred source has been restored, the control relay shall override the hold function and initiate an Auto Retransfer to the preferred source.

   iii) In the Auto Retransfer enabled mode, the control relay shall provide field selectivity of either Source Paralleling enabled (closed transition return) or Source Paralleling disabled (open transition) on re-transfer.

2) Transfer on Unbalance Condition
   i) An unbalance detection feature with a field selectable voltage level shall initiate automatic switching on detection of source-side open-phase conditions at the same system voltage level as the pad-mounted gear, whether caused by utility-line burndown, broken conductors, single-phase switching, equipment malfunctions, or single-phasing resulting from blown source-side fuses. The control relay shall continuously monitor the voltage to detect any based on a zero-sequence voltage unbalance present as a result of an open-phase condition. Automatic switching shall occur when the system unbalance-detect voltage is present for a period of time (field selectable) sufficient to confirm that the condition is not transient.

   ii) If Auto Retransfer enabled has been selected when normal phase voltages return to the preferred source, the control shall initiate re-transfer to the preferred source as described in 4. (a) (1) (ii) and (iii).

b) Control Features

1) The operating characteristics of the control relay and its voltage-, current-, and time-related operating parameters shall be field programmable and entered into the control by a laptop computer. To simplify entry of this information, a listing of all the field selectable functions shall be included in a single MM Transfer Settings file with tabs to all navigation to all the settings to allow changing the parameter setting using the laptop computer keyboard.

2) All operating characteristics and operating parameters shall be noted in instruction bulletins or otherwise available for review on the laptop computer.

3) The control relay shall have a large LCD screen to display the relay primary display points, which shall automatically scroll on the screen every five (5) seconds.

4) An LED with an appropriate label shall be furnished for indicating the presence of acceptable voltage on each phase of each high-voltage source.

5) A separate LED with an appropriate label shall be furnished for indicating the control relay operating mode (AUTO OR MANUAL) along with a soft key to allow direct selection of the applicable setting. In the manual mode, local electrical trip-open and trip-closed operation by means of pushbuttons shall be enabled while automatic switching shall be inhibited.

6) Separate LEDs shall be furnished for indicating the position of each switch.

7) Separate LEDs shall be furnished for indicating whether the motor operator is decoupled from the associated switch.

8) A separate test area shall be furnished with pushbuttons for simulating loss of voltage on each of the two sources.

9) A light-emitting lamp shall provide indication that the control relay is enabled and functioning properly.

10) The control relay shall provide for:

    i) Field selection by means of a laptop computer keypad of the timer setting that establishes the time delay between reduction of source voltage below the activation level and initiation of opening of the preferred source switch.

    ii) Field selection by means of a laptop computer keypad of the timer setting that establishes the time delay between return of source voltage to a value above the activation level and initiation of opening of the alternate source and reclosing of the preferred source.

11) The control relay shall incorporate an event log and shall have a LCD display to view settings and the event log entries.

12) The control relay shall allow for pushbutton selection of either source switch as the preferred source switch and shall provide an LED that illuminates to indicate the status.

13) The control relay shall provide a pushbutton and LED to allow reset of the Hold Return condition and the pushbutton shall have to be pressed and held pressed for three (3) seconds before the Hold Return is deactivated and the switch will subsequently initiate an immediate return transfer to the preferred source. The return transfer shall either be open return or closed return depending on the field selectable setting that has been chosen.
The control relay shall provide a pushbutton and LED to allow activation of the Remote Enabled function.

The control relay shall provide an LED to indicate that the motor operator are not in the same position (MISMATCH).

The control relay shall provide LED to indicate whether or not a motor operator is in a NO GO condition.

The control relay shall provide an LED to indicate whether the control is in Remote or Local.

A uninterruptable power supply (UPS) shall be provided to provide power to the control relay when both sources are lost and there shall be an LED that illuminates when the battery or battery charger are not functioning properly.

c) Construction Features

1) The control relay shall use components to provide the superior reliability required for use in power equipment. All components shall be selected to minimize the number of interconnections for increased reliability.

2) The control shall be located either in the grounded, aluminum or steel-enclosed low-voltage compartment with a motor operator or in a separate low-voltage compartment. The control compartment shall provide isolation from high voltage.

3) The control shall provide a ten (10) year warranty from the date of its manufacture.

d) Voltage Sensing and Control Power

1) Voltage sensing and control power shall be provided by a combination of voltage sensors or by fused voltage transformers on the line side of each phase of the source-interrupter switches.

2) The output of the voltage sensors or voltage transformers shall be directly proportional to system voltage and shall have accuracy over an ambient temperature range suitable for the application.

3) Constant current devices vulnerable to being open circuited and requiring a protective device for such eventuality and shorting-type terminal blocks shall not be used to provide voltage sensing and power for operation.

The following optional features may be specified:

e) Overcurrent Lockout

1) An over-current lockout feature shall be provided to prevent an automatic-transfer operation that would close a source-interrupter switch into a fault. The feature shall include a light-emitting lamp for indicating when a lockout condition has occurred, a reset key for manually resetting the lockout condition, and three current sensors for each source.

2) Provisions shall be furnished for manually resetting the over-current lockout feature from a remote location.

3) Test pushbutton shall be provided for simulating an over-current lockout condition on each source.

f) Remote Indication

Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence of preferred- and alternate-source voltage as well as the operating mode of the source-transfer control (i.e., Auto or Manual).

g) Supervisory Control

Supervisory control provisions shall be provided to permit switch operation from a remote location.

E. Labeling

1. Warning Signs

a) All external doors providing access to high voltage shall be supplied with suitable hazard-alerting signs warning of the electrical hazard inside the compartment.

b) The inside of doors to compartments in which bushings or bushing wells are mounted shall be supplied with a "Danger — High Voltage — Keep Out — Qualified Persons Only" sign.

c) Any barriers used to guard against access to energized live parts shall be supplied with a 'Danger — High Voltage — Keep Out — Qualified Persons Only' sign on both sides.

2. Nameplate, Ratings Labels, & Connection Diagrams

a. The outside of both the front and rear doors shall be provided with nameplates indicating an equipment description, name of manufacturer and type designation, catalog number, model number, serial number and date of manufacture.

b. The inside of each door shall be provided with a ratings label indicating the following: voltage ratings including maximum voltage rating and BIL; main bus continuous rating; short-circuit ratings (amperes, RMS symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings — continuous and interrupting; and interrupter switch ratings, including duty-cycle fault closing capability and amperes, short-time, RMS (momentary asymmetrical and one-second symmetrical), the total weight; and a schematic diagram.

c. The schematic diagram shall be a three-line connection diagram showing interrupter switches, motor operators, current sensors (or current transformers), voltage transformers, fuses and bus along with the manufacturer’s model number shall be provided on the inside of both the front and rear doors, inside the door of each motor operator, and on the inside of each switch operating hub access cover.

F. Accessories

The following optional features may be specified:

1. Furnish fuse components of the type specified by the purchaser. No fuse units shall be supplied unless actually noted by the purchaser in the specifications available to the switchgear manufacturer at the time of quotation.

2. Grounding elbows as recommended by the switchgear purchaser.

3. Load-break inserts as required by the switchgear purchaser.
TYPE PVE
DEAD-FRONT VACUUM INTERRUPTER
PAD-MOUNTED SWITCHGEAR
15kV • 25kV

Featuring:

- Visible Disconnect on Each Vacuum Interrupter
- Vacuum Interrupter Switches – 200 amp and 600 amp
- Resettable Vacuum Fault Interrupters – 200 amp and 600 amp
- Electronic Trip Control of Vacuum Fault Interrupters
- Three-Phase Switching & Fault Protection
- Two-Way and Multi-Way Configurations
- Front Access or Front and Rear Access
- External Manual or Motor-Operation
- 200 amp Bushings Wells
- 600 amp Bushings
- Insulated Main Bus

Federal Pacific PVE Models of Pad-Mounted Switchgear combine air-insulated vacuum load-break interrupters for switching of primary feeders with air-insulated vacuum fault interrupters for protection of lateral load-feeder circuits. These vacuum switching and protection components are arranged in a variety of circuit configurations to provide the range of choices typically available in all other types of pad-mounted switchgear, including manual, supervisory-controlled, automatic-transfer and automatic sectionalizing (self-restoring) models. The vacuum interrupters are enveloped in a rugged 11-gauge steel enclosure with cable connections through 600 ampere bushings or 200 ampere bushing wells achieving a dead-front design with high-voltage components isolated from the environment by a galvanized-steel floor plate.
There is a choice of manual or electronically controlled tripping on all vacuum interrupters, which also feature an integral visible disconnect, providing the optimum arrangements for distribution system switching, protection and isolation applications.

Vacuum Interrupters With Visible Disconnects, Both User Friendly and Environmentally Friendly

Federal Pacific’s VIVD® (vacuum interrupters with visible disconnect) technology is the ultimate in environmentally secure switchgear incorporating air-insulated vacuum interrupters. The enclosure controls moisture, restricts entry of airborne contaminants, prevents penetration by animals and the curious while also ensuring security for operating personnel (by providing a visible gap after the vacuum interrupter opens) and the public (by eliminating exposure to hazardous materials or conditions).

VIVD’s® evolutionary configuration solves the dilemmas not previously addressed by all other insulating mediums whether liquid-filled, gas-filled or solid-dielectric equipment … namely, providing an environmentally friendly insulating and isolating medium.

Liquid Insulation Mediums

Liquid dielectrics, whether-or-not they are biodegradable, have the propensity to ignite under the influence of an electrical arc, which reaches many thousands of degrees, creating an environmental and personnel hazard. In addition, liquid dielectrics consume resources that are best saved for use in other energy and food applications. Furthermore, the insulating property of liquid dielectric must be closely monitored to verify its quality and integrity and freedom from contamination by moisture and particulate material.

Liquid dielectrics are very heavy materials and, therefore, require high-capacity moving and handling equipment as well as substantially reinforced sub-structures on which to place them for installation or other mountings.

Gas (SF6) Insulation Mediums

Gas-filled units nearly always utilize sulphur hexaflouride (SF6), which is identified as the worst green-house gas that threatens the global environment. Equally detrimental as a severe health hazard, SF6 gas will form carcinogenic materials when it is exposed to an electrical arc. The high temperature of the electrical arc breaks down the SF6 gas into products that have been proven to cause cancer. The quality and quantity of SF6 gas within an interrupting chamber must be closely monitored and assured prior to performing any switching operation to avoid an eventful failure if insufficient gas is present or if it has become contaminated by moisture.

Equipment utilizing SF6 gas cannot be sealed to completely eliminate leakage of the gas, consequently refilling is inevitable and facility to remove and refill must be provided. Another concern and consideration is that reclamation equipment for housing SF6 when repair or replacement is necessary is expensive and cumbersome. The Federal government has implemented ever increasing stringent reporting requirements on the use and emissions of SF6 gas into the environment. Therefore, it is evident that the handling and disposal of equipment containing SF6 will gain increasing scrutiny in the future.
Solid-Dielectric Mediums
Units that incorporate solid materials, such as rubber and epoxies, as the insulating medium also present detrimental impact on the environment and may have a hidden potential to develop disruptive failures. These compounds, rubber and epoxies, do not biodegrade in any reasonable time frame and are therefore materials that are harmful to the environment. Furthermore, these compounds require considerable energy to manufacture, consuming resources that are better utilized for other applications. Solid-dielectric materials typically are employed to encapsulate vacuum interrupters. But, these encapsulated interrupters have not been successfully integrated with a visible disconnect that does not compromise the operational security and ease of operation afforded by insulation in air. Also, the additional space required to add a visible gap may compromise the smaller footprint afforded by the solid-dielectric design.

Air-Insulated Mediums
Air as an insulating medium is replenishable and self renewing and thereby avoids the inherent hazards associated with every other insulating medium. Air is a naturally occurring compound that does not deplete or consume other energy resources in its production. An air-insulated electrical component does not require a refill valve, a pressure indicator or a volume level gauge. Air involved in an electrical arc does not develop any hazardous properties. Air is the most economical insulating medium. Air is the ultimate green-energy technology for switching and protection on electrical power distribution circuits. Since air is an environmentally neutral medium, it is successfully used in the widest range of applications to provide insulating properties that are fully effective when combined with appropriate design controls. In-air insulation, manifested in the VIVD® technology, provides the visible open gap not offered by most other varieties of switchgear with vacuum interrupter technology. Each group-operated vacuum interrupter is integrated with a three-pole, group-operated visible disconnect. The integrated arrangement has the vacuum interrupter mechanically and electrically interlocked with the visible disconnect such that the disconnect cannot be opened until after the vacuum interrupter has opened to interrupt the circuit. Furthermore, similar interlocking makes certain that the vacuum interrupter cannot be closed until after the visible disconnect is closed.

Eliminating reliance on liquid (oil), gas (sulphur hexafluoride — SF6), and solid materials (rubber and epoxy) as encapsulating and insulating materials, and utilizing air as a dielectric medium in a controlled environment, VIVD® Technology Switchgear is the leading-edge green technology revolutionizing distribution system reliability while providing unsurpassed operational flexibility.

VIVD® Technology Switchgear . . . Enhances Reliability with Air-Insulated Vacuum Interrupters
With over fifty years of design, development and manufacturing experience in the electric power industry, Federal Pacific brings its PVE line of switchgear products and components to enhance the security and reliability of underground distribution systems. The major components of Federal Pacific’s VIVD® technology system include an air-insulated load-break vacuum interrupter switch for switching of main-primary feeders, air-insulated vacuum fault interrupters for switching and fault protection on distribution lateral load-feeder circuits, visible disconnects on all vacuum interrupters for confirming circuit isolation, trip-free operating mechanisms for instantaneous circuit interruption if closed onto a fault and an electronic sensing package for reliable tripping fault interrupters in response to overcurrent conditions.

Vacuum Interrupters
Since its first use in the 1920’s, vacuum technology has become the interrupting medium of choice. Vacuum circuit breakers have nearly 60 years of service in the severest of environments. Vacuum interrupters are efficient with a very low failure rate and are maintenance free. Vacuum technology issues no damaging ozone-depleting emissions. Vacuum interrupters contain all interrupting materials preventing any ionized gases from causing flashover of insulators to ground or phase-to-phase.
Vacuum interrupters separate a set of contacts within an evacuated chamber. Vacuum interrupters are extremely compact and the circuit interruption process is virtually silent, with any noise associated with the operating mechanism. All of the materials used are benign to the environment. The vacuum chamber is of a ceramic material. Metals of various types comprise the contacts, shields and terminals. The interrupting capability of vacuum interrupters can exceed the mechanical capability of the operating mechanisms.

Contact technology enhancements have made vacuum interrupters the dependable preferred methodology for circuit interruption. With vacuum interrupters there are no gases discharged to contaminate adjacent components or the dielectric. Vacuum interrupters can be mechanically reset easily so there are no components to be replaced after an operation. Vacuum interrupters are capable of an exceptionally large number of mechanical and electrical operations before service may be necessary, if ever.

**Vacuum Fault Interrupters**

Federal Pacific’s 15kV vacuum fault interrupters are available with continuous current ratings to 1200 amperes and short-circuit interrupting ratings to 18,000 amperes rms symmetrical, 28,800 amperes rms asymmetrical. And, Federal Pacific’s 25kV vacuum fault interrupters are available with continuous current ratings to 600 amperes and short-circuit interrupting ratings to 12,500 amperes rms symmetrical, 20,000 amperes rms asymmetrical.

Federal Pacific combines three (3) vacuum interrupters with an operating mechanism to achieve three-phase load-break operation and avoid single phasing. With three-phase operation, vacuum interrupters virtually eliminate the possibility of ferro-resonance that may occur with single-phase operation of lightly loaded circuits. In addition, the superior vacuum dielectric in the interrupter makes the possibility of restrikes and flashovers negligible. An operating mechanism combined with a reliable vacuum load-break interrupter insures the durability of the switching device over the anticipated life of the switchgear.

The vacuum fault interrupters are high-precision hermetically sealed contact systems that provide an effective, efficient means to interrupt rated fault currents. This capability has been proven in testing to ANSI/IEEE C37.60 which requires 116 fault interrupting operations over various percentages of the symmetrical short-circuit rating. All vacuum fault interrupters include an integral visible disconnect and an independent wear indicator on each phase, plus each phase has the capability to be independently adjusted to achieve proper contact pressure.

The exceptional switching and fault-closing capabilities of vacuum fault interrupters makes “fault hunting” more practical than ever before. And, the trip-free functionality of vacuum fault interrupters allows interrupters to immediately open when closed on a fault. That trip-free capability of vacuum fault interrupters minimizes exposure to excessive overcurrents and heating that shorten life-cycle operations due to insulation breakdown.

The vacuum interrupters are high-precision hermetically sealed contact systems that provide an effective, efficient means to interrupt load currents. These interrupters have the capability to interrupt the rated load current for up to 10,000 operations.
Visible Disconnects

Personal security is an important consideration in the development of all switches and fault interrupters. One of the primary advantages of air-insulated equipment has over liquid-filled, SF6-filled and solid-dielectric equipment is the ability to provide a superior integral bushing. Air-insulated switchgear avoids the necessity to compromise the visible disconnects. Liquid-filled designs either utilize a semaphore signal or an obscure arrangement viewed through a distorting liquid. Similarly, SF6-filled designs either utilize a semaphore or a less visible disconnect arrangement, which if in the gas medium has the potential to leak and create hazardous materials when an event occurs across the open gap — a real possibility for units that are known to leak and lose dielectric. A viable visible disconnect has not been developed for solid-dielectric designs, which if not imbedded in the dielectric material will either be expensive or compromise the advantage of solid dielectric if it remains in an air environment.

Bushings and Bushing Wells

Insulators of cycloaliphatic epoxy (CAE) polymers have been used in the power industry for over fifty years and have proven field experience globally in both indoor and outdoor applications. These polymers are lightweight, homogeneous and readily molded by the automatic pressure gelation (APG) process in both simple and complex contours. The formulation is balanced for high voltage, high strength, non-tracking, self-scouring, non-weathering applications in extremes of high temperature and sub-zero cold.

Federal Pacific’s bushings and bushing wells are of cycloaliphatic epoxy and meet all the criteria set forth in ANSI/IEEE 386, which establishes ratings and design interface to accommodate industry standard insulated separable elbow connectors. To ensure the long-term survivability of Federal Pacific bushings and bushing wells, every individual unit is x-rayed in a 360° top-to-bottom examination to insure the integrity of the insulation. All bushings and bushing wells feature high conductivity copper rod contacts and include removable silver-plated copper studs. In addition, bushings and bushing wells all carry an engraved serial number for quality audit if the need should ever arise and are traceable to the particular switchgear assembly.

Figure 8. Federal Pacific’s Visible Disconnect (shown open) is available on all Federal Pacific Vacuum Interrupter Switches and Vacuum Fault Interrupters.

Figure 9. Federal Pacific cycloaliphatic bushings and bushing wells have all copper conductors and silver-plated removable studs. Semi-conductive coating isolate bushings and dust covers protect high-voltage interfaces.
Overcurrent Protection

Federal Pacific’s vacuum fault interrupters response to overcurrents occurring on load-feeder circuits is controlled by either a self-powered relay (see Figure 10) that energizes a magnetic latch to trip the vacuum fault interrupter or by an SEL-501 Dual Universal OCR (see Figure 11) or similar overcurrent relay (OCR).

The self-powered relay in combination with the magnetic latch is utilized when vacuum fault interrupter operation is to be performed manually using the manual operating handle mounted on the side of the pad-mounted switchgear (or the manual trip-open button on the faceplate). Power for the relay is generated by the current transformers used for sensing the overcurrent.

The SEL-501 relay (see Figure 11) requires that control power always be available and is used when the vacuum fault interrupter is to be motor-operated and also requires a UPS so that operations can be performed even when control power is lost. The relay and motor will then be powered by a control-power source, typically a voltage transformer. The SEL-501 relay provides overcurrent response for two vacuum fault interrupters in a single compact package. The relay is readily programmed to provide the specific relay curve that is desired for the particular application.

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

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

Motor Operators

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

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

Optional controls are also available to permit motor operation and all tripping functions to be performed from a local but isolated location. By operating the unit by means of such a local, portable control station will eliminate concerns over exposure to arc-flash hazards.

Figure 10. The self-powered relay components include (1) the relay that provides all the settings and controls necessary to initiate vacuum circuit-breaker operations based on the programmed parameters, (2) the magnetic actuator pictured that provides mechanical trip-actuation of the vacuum circuit-breaker mechanism and (3) the current-sensing transformer that provides sensing and power input to the relay and trip circuit.

Figure 11. Overcurrent Protection is provided using The SEL-501 Dual Universal OCR (see above left). Each OCR relay control can handle two vacuum fault interrupters. A UPS (at bottom in above left photo) is included to make certain control power is always available for operation of the relay to trip the vacuum fault interrupter in response to a fault a UPS is included. A current transformer (see above right) is used to sense the overcurrent condition and provide that input to the SEL-501 relay.

Figure 12. Motor Operators Can Be Added To All Federal Pacific Vacuum Interrupters As Pictured At The Bottom Right On The 15Kv Vacuum Fault Interrupter Above.
**Figure 13. Enclosure Exterior of Federal Pacific PVE Vacuum Interrupter Pad-Mounted Switchgear.**

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

**Figure 14. Incoming Termination Compartments of Vacuum Load-Break Switched Ways.**

1. Hazard-Alerting Danger Signs On Interior
2. Stainless-Steel Windbrace
3. Three (3) Stainless-Steel Hinges & Hinge Pins Per Enclosure Door
4. Bumper Gasket Cushions Door Interface, Prevents Metal-To-Metal Contact
5. Center Steel Divider Isolates Termination Compartments
6. Closed-Cell Gasket Seals Roof To Equipment-Mounting Panel
7. Phase Identification Labels
8. Compartment Identification Labels
9. 600 Ampere Cycloaliphatic Epoxy Bushings With All-Copper Conductor On Stainless-Steel Clamping Bracket
10. Removable Silver-Plated All-Copper Stud On All Bushings With Red Protective Dust Covers
11. Stainless-Steel Parking Stand For Each Bushing
12. Cross-Kinked, Galvanized-Steel Floor Plate Isolates Vacuum Interrupters And Bus
13. Stainless-Steel Screened 1" Vent In Each Corner Of Floor Plate Allows Any High Ground Water or Flooding To Drain Out
14. Formed-Steel Equipment-Mounting Panels Isolate High-Voltage Components From Termination Compartments
15. Wide-View Clear Polycarbonate Window For Viewing Visible Disconnect On Vacuum Load-Break Switches
16. Vacuum Load-Break Interrupter Switches
17. Stainless-Steel Door-Latch Pins
18. Visible Disconnects For Vacuum Load-Break Interrupter Switches
19. Continuous Ground Bus In Vacuum-Switch Termination Compartments
1. Compartments Provide Access To Manual-Operating Handles Of Vacuum Interrupters
2. Fused-Voltage Transformers For Sensing And Control Power For Relayed Vacuum Fault Interrupters
3. Viewing Window Provides Visibility And Access To Fused-Voltage Transformers
4. 600 Ampere Bushings For Fault Interrupters
5. Stainless-Steel Mounting Plate And Parking Stand For Each Bushing
6. Viewing Windows For Fault Interrupters
7. Vacuum Fault Interrupters
8. Visible Disconnect For Vacuum Fault Interrupters
9. Self-Latching And Resetting Three-Point Door Latches
10. Penta-Head Actuated Self-Latching Door Operating Mechanism
11. Undercoating Is Applied In Door-Flange Channel, Which Includes Drain Holes, To Provide Protection Against Accumulation Of Contamination And Moisture
12. Storage Pocket
13. Current Transformers For Overcurrent Sensing On Vacuum Fault Interrupters (Optional Window-Type CTs Shown)
14. Optional Split-Core Current Transformers For Overcurrent Sensing
15. Continuous Copper Ground Bus Across Door Opening Of Load-Feeder Termination Compartments
16. Optional 200 Ampere Bushing Wells To Replace 600 Ampere Bushings
17. Optional Mounting Provisions For Fault Indicators

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

Figure 16. Faceplate of Vacuum Fault Interrupter.

Figure 17. 15kV Vacuum Fault Interrupter With Optional Motor Operator.

Figure 18. 27kV Vacuum Fault Interrupter With Optional Motor Operator.
1. Load-Break Vacuum Interrupter
2. Outgoing (Load-Side) Contacts
3. Contact Pressure Counterweight
4. Visible-Disconnect Operating Link
5. Visible-Disconnect Operating Shaft
6. Stationary Contact For Visible Disconnect
7. Disconnect Blade Closed
8. Disconnect Blade Open

Figure 19. Vacuum Load-Break Interrupter Switch

Figure 20. Integral Visible Disconnect — Disconnect Closed.

Figure 21. Integral Visible Disconnect — Disconnects Open.
Figure 22. Features of Low-Voltage Enclosure for Relay and Controls. Configuration varies depending on specified requirements and relay used (shown with SEL-501 relay).

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

Figure 23. Relay and Control Compartment Component Identifications. Configuration varies depending on specified requirements and relay used (shown with SEL-501 relay).
### SPECIFICATIONS

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

* If integrated with relay control.

**NOTE:** For higher continuous current or fault current capabilities, contact the factory.
FEATUERS:

• Live-Front 600-Ampere Switch Compartments
• Dead-Front 200-Ampere Fuse Compartments
• Manual, Automatic Source Transfer, SCADA Controlled
• PLD-5, PLD-6, PLD-9, PLD-11
• Meets all of the preferred and optional ratings in IEEE C37.74.
• Meets Enclosure Security Requirements in ANSI C57.12.28
• 600 ampere or 1200 ampere Switches and Bus

Federal Pacific offers PLD Pad-Mounted Switchgear to provide an additional switchgear equipment choice for implementing underground distribution systems. The PLD units offer the application flexibility and operating convenience of both live-front and dead-front pad-mounted switchgear. Application flexibility is achieved by providing the PLD units in the most popular circuit configurations. Operating convenience is achieved by developing a design that combines the most desirable features for terminating cable, switching and protecting main and load feeders, and insuring optimum security for personnel; hence, the acronym PLD — Pad-Mounted Live-Front, Dead-Front.

The switch compartments are configured for live-front operation. The switch is Federal Pacific’s standard Auto-jet® II Load-interrupter Switch with terminal pads accessible and configured to accept conventional skirted terminators. The rugged dependability of the Auto-jet switch has been laboratory tested and field proven to provide ratings and performance superior to any available in air-insulated pad-mounted switchgear.

The fuse compartments are configured for dead-front operation. The fuse mountings are identical to those used in Federal Pacific’s dead-front line of PSE Pad-Mounted Switchgear. The PLD fuse mountings incorporate Federal Pacific’s 200-ampere bushing wells, which meet all the requirements of ANSI 386 and accommodate load-break inserts for use with 200 ampere load-break elbow connectors.

The standard unit ratings are 15kV with 600 ampere bus. The circuit configurations are the PLD-5, PLD-9, and PLD-11. These are the most popular models in all of the pad-mounted switchgear designs. Other circuit configurations may be made available. For example, units with 1200 ampere switches and 1200 ampere bus have also been designed and built and are available in the foregoing model designs.
Enclosure integrity and security is assured with Federal Pacific Type PLD Pad-Mounted Switchgear.

Live-Front switches utilize conventional, skirted terminators and eliminate the need for costly, difficult to handle 600 ampere elbow connectors.
Interior view of fuse-termination compartment of Federal Pacific PLD Pad-Mounted Switchgear. Unit includes many features to assure ease of operation for personnel when switching elbows or inspecting and re-fusing 200 ampere circuits.
Typical dimensions and configurations for models of Federal Pacific PLD Pad-Mounted Switchgear. Refer to factory for other available circuit configurations. (Dimensions not for construction purposes.)
The Type FTDF Pad-Mounted Switchgear offers dead-front load-break elbow switching of radial and loop feed systems with (non-loadbreak) fuse protection on laterals and taps. FTDF’s are available in 15kV and 25kV voltage class, single and three-phase with either general-purpose type current-limiting or expulsion-type power fuses.

The basic enclosure has been designed to present the lowest possible silhouette, yet maintaining ample operating and electrical clearances. An all-welded 11-gauge steel construction provides additional strength and rigidity to the housing. Doors have flush handle with padlocking provisions and a separate penta-head security bolt operates with a three-point latching system. Ventilation louvers are of baffle and screen construction that allows air to circulate and prevents the insertion of wire or other foreign material. These standard features, along with a rugged tamper-resistant design, provide a unit that meets the stringent security requirements of ANSI C57.12.28.

FTDF cabinets are divided into two compartments. Elbow compartments consist of a steel equipment panel with in-air bushing wells to accept load-break inserts and elbow, one parking stand per bushing well, and phase, line and load designations. Fuse compartments contain applicable non-loadbreak fuse mountings and phase barriers and hinged inner barriers of red fiberglass and complete with penta-head bolts. Loadbreak fuse mountings are available as an option. Barriers of clear polycarbonate are available as an option.

High quality steel, corrosion-resistant hardware, chemical cleaning and phosphatizing, corrosion resistant epoxy-powder primer and a baked powder finish coat make the anti-corrosion coating system a leader in the industry. The finish coat is an oven-baked polyurethane; standard color is pad-mount green, Munsell Notation 7.0 GY 3.20/1.5. Optional colors and severe environmental systems are available. The underside of the roof section is coated with a "no-drip" anti-condensation compound.

A wide range of optional features are available, including hex-head security bolts and base spacers to increase cable training height and 600 amp dead-break apparatus bushings on line side.

### Optional Features

- **AB**: 600 amp dead-break apparatus bushing on line side.
- **AJ4Z**: Auto-jet fuse mounting and live parts only. Requires S&C SML-4Z fuseholders.
- **AJ20**: Auto-jet fuse mounting and live parts only. Requires Federal Pacific FP-3097, S&C SML-20, Cutler-Hammer DBU or Cooper CMU fuse end fittings.
- **AS**: Arc strangler fuse mounting, Mounting Code 1 or 2.
- **B6***: Inner insulating doors, complete with hex-head bolt, fuse side only.
- **BSC6**: Base spacer, 6 inch, compartmented.
- **BSC12**: Base spacer, 12 inch, compartmented.
- **F2**: Finish, light gray, ANSI, instead of green.
- **LBI**: Load-break bushing inserts for all line and load bushing wells.
- **LF**: Live fuse termination (delete load-side bushings).
- **SB2**: Security bolts hex-head instead of penta-head.
- **U2**: Coal tar base and 3" up all sides.

APPLICATION DATA

CL Designation: Standard current-limiting fuse mountings are Code 5/6 for mounting Cooper NX; Cooper ELX; General Electric GP and Cutler-Hammer CX clip style fuses. The Code 5/6 mountings provide a fuse range of 1.5 to 100 amps at 13.5kV, 1.5 to 80 at 15.5kV and 6 to 40 amps at 23kV. Arc-strangler fuse mountings Code 2 are available at 15.5kV with a fuse range of 1.5 to 40 amp. Other current-limiting fuses are available on special order. Fuse mountings only are supplied; fuse units can be provided as an option.

PF Designation: Standard power fuse mountings accommodate S&C SM-4Z or SM-20, Eaton (Cutler-Hammer) DBU, or Cooper CMU all with a fuse range of 1 to 200 amps at 15.5 and 25kV. Other power fuses are available on special order. Fuse mountings only are supplied; fuseholders, refills, end fittings and fuse units can be provided as an option.

Auto-jet load-break fuse integral load interrupter as described on page 13 is available as an option. The Auto-jet fuse mounting has a load interruption mechanism that permits single-phase switching of the fused circuit by use of an ordinary hotstick equipped with an appropriate fuse-handling tool. Fuse mountings and end fittings only are supplied; fuseholders and refills can be provided as an option.

Bushing Wells and Bushings: Federal Pacific bushing wells are provided to accept optional load-break inserts and customer elbows. Bushing wells and bus are rated 200 amps continuous, 95kV BIL on 15kV units and 125kV BIL on 25kV units. Bushings and bushing wells meet the requirements of ANSI 386 standard.

Elbow Switching: The 15kV units are designed for use on 15kV class, 4-wire multi-grounded systems or 3-wire ungrounded systems. Elbow switching, 200 amperes maximum, at 8.3kV phase-to-ground and 14.4kV phase-to-phase can be accomplished with proper load-break inserts and elbows.

The 25kV units are designed for use on 25kV class, 4-wire multi-grounded systems or 3-wire ungrounded systems. Elbow switching, 200 amperes maximum, at 15.2kV phase-to-ground and 26.3kV phase-to-phase can be accomplished with proper load-break inserts and elbows.

Certain inserts and elbows may lower these ratings.

Optional non-loadbreak 600 ampere bushings can be provided in lieu of 200 ampere bushing wells.
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<td>36 40 57</td>
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<td>25</td>
<td></td>
<td>50 60 84</td>
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</table>
Typical — Single Phase

FTDF - 115 - 21CL
Shown with code 5/6 clip style fuse.
Approximate weight 320 lbs.
15 kV Class

FTDF - 125 - 31 - PF
Shown with code 5/6 clip style fuse.
Approximate weight 450 lbs.
25 kV Class
TYPICAL — THREE PHASE

FTDF - 315 - 63CL
Shown with code 5/6 clip style fuse.
Approximate weight 320 lbs.
15 kV Class

Section A-A
(Shown with Code 5/6 Clip Style Fuse)

FTDF - 325 - 63CL
Shown with code 5/6 clip style fuse.
Approximate weight 400 lbs.
25 kV Class

Section A-A
(Shown with Code 5/6 Clip Style Fuse)
TYPICAL — THREE PHASE

FTDF - 325 - 93CL
Shown with code 5/6 clip style fuse.
Approximate weight 680 lbs.
25 kV Class

FTDF - 325 - 93CL
Shown with code 5/6 clip style fuse.
Approximate weight 720 lbs.
25 kV Class
TYPICAL — THREE PHASE

FTDF - 315 - 126CL
Shown with code 5/6 clip style fuse.
Approximate weight 425 lbs.
15 kV Class
TYPICAL — THREE PHASE

FTDF - 315 - 126PF
Shown with S & C SM-4Z fuses.
Approximate weight 1100 lbs.
15 kV Class

Plan View
(Shown with optional 200 Amp Line Bushing Wells)

Front View — Doors Removed

Section A-A
(Shown with S&C SM-4Z Fuse Holders)

Front View
Federal Pacific three-phase primary-metering cabinets meet applicable industry standards, which include ANSI 386 and IEEE C57.12.28, and are available in ratings of 15kV through 35kV. The flexible design can accommodate several different types of current transformers and potential transformers, providing a convenient, weather protected, tamper-resistant enclosure for revenue metering at primary voltages on underground cable systems.

The PMDF termination compartment features a dead-front steel barrier with six (radial) or nine (loop) Federal Pacific 200 amp bushing wells accommodating load-break inserts and elbows. Optional 600 amp bushings are available. In addition, accessory parking stands and three 1/2” stainless-steel grounding nuts are included. Large door openings provide excellent accessibility for elbow operation. All doors are padlockable with rugged three-point latching.

The instrument-transformer compartment has provisions for mounting CTs and PTs (not included). A ground bus is provided and located for easy access to PTs. An insulated, hinged inner barrier with pentahead-bolt closures is standard.

PMDF enclosures, roofs and doors are 11-gauge hot-rolled steel, all welded construction. High quality steel, corrosion-resistant hardware, chemical cleaning and phosphatizing (or zirconization) corrosion resistant epoxy-powder primer and a baked powder top coat make the anti-corrosion coating system a leader in the industry. Standard finish color is pad-mount green, Munsell notation 7GY3.29/1.5. Optional colors are available. Special coatings are available for severe environments. The underside of the roof is coated with a "no-drip" anti-condensation compound.

Primary-metering requirements are also available in custom designs incorporating fusing and switching arrangements as well as optional externally mounted kWh meters and low-voltage compartments. Consult factory for dimensions, configurations and optional features.
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<th>kV Nom.</th>
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<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
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*Dimensions not for construction purposes.
Pad-mounted capacitor banks with dead-front bushing wells for connection of entrance cables are available in ratings of 15kV and 25kV. Federal Pacific has the capability to build capacitor banks in a variety of configurations, but has developed the pad-mounted configuration for electric utility accounts. These pad-mounted capacitor banks have broad applicability throughout the industry, including non-utility facilities.

The capacitors are installed to boost the voltage back within the operating tolerance of the system and, thereby, provide voltage stability. Without capacitors, load circuits will operate at reduced voltage...motors will run slower and overheat, lights will not burn as bright, relays in process industries will drop out, etc., creating end-user system disturbances.

Capacitors extend the range of substations by allowing feeder circuits to have longer runs of cable. Extending the range of substations also means that capacitors serve to increase network capacity. For individual customer facilities, it may be necessary or desirable to provide improved voltage regulation at the installation. For this purpose, on-site pad-mounted capacitor banks near customer loads provide power factor correction.

Figure 1. Exterior view of Federal Pacific Pad-Mounted Capacitor Bank. Pad-Mounted capacitor banks bring aesthetic view to field installations, eliminating clutter on overhead poles, while also making certain that components are not exposed to the environment.

Figure 2. Dead-front compartment with bushing wells to accommodate inserts and elbow connectors (not furnished) for cable entry. Units are furnished with clear polycarbonate barrier in dead-front compartment to permit viewing vacuum interrupter targets.

Figure 3. Live-front compartment of pad-mounted capacitor bank. Unit is shown with front barrier over fused voltage transformer and compartment front barriers removed. Red GPO-3 fiberglass barriers are standard. Optional clear polycarbonate barrier in live-front compartment, which provides enhanced visibility over standard red fiberglass barrier, are available.
Federal Pacific pad-mounted capacitor banks have three (3) major advantages: voltage stability, increased network capacity, and power factor correction. These all combine to provide cost savings through lower system losses.

For application in the electric industry, individual capacitor units are rated in kvars (kilovars-ampere reactance) and are applied in banks called shunt-capacitor banks. For underground distribution systems, capacitor banks are installed in pad-mounted enclosures as small, distributed installations that are connected to main-primary feeder circuits at a considerable distance from the substation. These distributed banks can be fixed on the circuit or switched on and off as dictated for system stability.

A three-phase capacitor bank is arranged with one or more capacitors in each phase (called a leg) of the bank. Typical sizes for individual capacitors are 100 kvars, 200 kvars, and 300 kvars, up to 600 kvars. Units of less than 100 kvars are also available. If there is more than one capacitor in each leg, the capacitors are connected in parallel. For capacitors in parallel, the kvars add so that a bank with two (2) 200-kvar capacitors per phase would be a 1200 kvar bank.

### Components & Application Data

**Bushings and Bushing Wells:** Federal Pacific provides cycloaliphatic epoxy bushings (600 amperes) or bushing wells (200 amperes) to all capacitor banks in order to supply input connections from the main-primary feeder to the pad-mounted capacitor bank. These connections can either be radial through a single three-phase set of connectors or looped through two (2) three-phase sets of connectors. Federal Pacific bushings and bushing wells are designed to ANSI 386 requirements and, therefore, accommodate all similarly designed load-break and non-loadbreak elbow connectors, components, and accessories. Load break elbows are not to be used for switching the capacitors.

**Fuses:** Federal Pacific provides fuses to pad-mounted capacitor banks in order to protect the circuit in the event of a fault in the bank. In the smaller pad-mounted capacitor banks, each leg is fused and the bank taken off-line when one capacitor fails because the over-voltage is too great on the remaining capacitors. Current-limiting fuses help to prevent capacitor case rupture.

**Switches:** Federal Pacific provides switches in each leg to take the bank on- or off-line. Capacitor switching is an extremely tough duty and switching can be frequent. The duty is severe because the rate of rise of recovery voltage during a switching operation is very steep, which can cause a re-strike if the dielectric is not adequate. Air is not typically used as the insulating medium for capacitor switches because the length of the air gap and the size of the switch has to be large to avoid a re-strike.

The frequent switching requirement is best handled by a vacuum switch, which has very little wear on its contacts during switching. Insulating medium available for the vacuum interrupter includes oil, SF6 gas, and solid dielectric. Federal Pacific allows the customer to choose the brand of capacitor switch they prefer.

**Inductive Reactors:** Federal Pacific provides inductive reactors in capacitor banks in order to tame the capacitor switching duty by reducing switching in-rush surges and limiting the fault current. The reactors used in Federal Pacific’s Pad-Mounted Capacitor Bank are made by the Federal Pacific Transformer Division, which has made inductive reactors for capacitor-bank applications for many years.

**Control Components:** Federal Pacific provides control components in order to supply control power, sensing, and the switching capability necessary to switch on-and off-line. A fused voltage transformer (1500va) is tapped to the high-voltage circuit and supplies control power for the pad-mounted capacitor bank. The secondary of the voltage transformer includes a low-voltage circuit breaker for switching and protecting the secondary circuit.

Optionally, the transformer can be used to provide sensing voltage input proportional to the line voltage to a controller. The optional control (or controller socket) uses the input voltage as a measure of line voltage, which establishes whether the capacitor bank is to be switched on-or off-line. Such switching can be performed manually by locally using the handle on the capacitor switch, which is hookstick operable.

Switching can alternately be performed with the capacitor switch relays for automatic switching, which will include a capacitor-trip device, and remotely when the customer provides appropriate communication components. All of these components can be arranged within a compact enclosure. The circuit diagrams for a few different pad-mounted capacitor banks are illustrated in Figure 5.

### Pad-mounted capacitor banks have valued advantages for the underground distribution system:

1. They extend the ability of the power supply system to support longer lines to the load.
2. Growing systems into newer developments are more typically served underground and pad-mounted capacitor banks fit this growth segment.
3. The enclosed components offer a more aesthetic appearance than exposed overhead components, making them well suited for utility, industrial, commercial, and institutional installations.
4. The enclosure affords considerable protection from the environmental flora and fauna.
5. Access to components is easier to achieve at ground level than on a pole.
6. Component integration can be arranged in a fairly low-profile enclosure.
7. Underground circuits are less prone to storm damage.

### Optional Features

When ordering, specify optional features desired by adding individual suffix letter designations following the last digit of the catalog number of the unit specified developed using the chart of Catalog Number Designations in the “HOW TO ORDER” section on the next page.

For example, a 15kV 1200 kvar capacitor bank with 200-ampere bushing well for loop-through application using a solid-dielectric switch and NX current-limiting fuses, GE capacitors, a mounting ring for a controller and a copper bus instead of aluminum will have the designation: CB42 – 26U – NGYY2-C.
Figure 5. The circuit diagrams for a few different pad-mounted capacitor banks are illustrated above. These illustrations show all the major components. Consult the factory for alternate designs.
1. **Ventilated at Roof**—Interior ventilation maze helps keep interior dry.

2. **“No-Drip” Compound** – Coating insulates underside of roof to control moisture condensation.

3. **Cross Break on Roof** – Provides slope to roof to keep moisture from collecting on top.

4. **Ventilated at Doors** – Deep overlapping of doors with enclosure door-opening flanges develops a ventilation maze to increase air movement inside while restricting penetration.

5. **Gasket Bumpers** – Around door opening on flanges protect finish from metal-to-metal contact.

6. **Stainless-Steel Windbrace** – Secures doors open from wind-blown closure.

7. **Automatic Door Latches** – Self-latching, self-resetting three-point arrangement has no fast moving parts to snag personnel; automotive-type door latches pass severe test requirements. Moving parts, springs and bushings are stainless steel.

8. **Hazard Alerting Signs** – Necessary warnings are provided on long-life labels

9. **Stainless-Steel Hinges and Pins** – Ensure proper door operation without sticking.

10. **Enclosure Ground Pad** – In termination compartment, allows connection of concentric neutrals and enclosure ground rod.

11. **Ground Bus** – Round edge copper bus across full width of compartment allows connection of grounds.

12. **Current-Limiting Fuses** – Provide protection for capacitor bank.

13. **200-Ampere Bushing Wells** – Federal Pacific cycloaliphatic bushing wells meet ANSI 386 requirements; accommodates all brands of inserts and elbows – not to be operated when capacitor switch is closed.

14. **Removable Clear Polycarbonate Barrier** – Secured to enclosure with penta-head bolts; lifts off to provide access to fuses. Red GPO-3 insulating fiberglass barriers are standard.

15. **11-Gauge Steel Enclosure, Roof and Doors** – Provides exceptionally tough, electrically bonded, durable enclosure protecting components from vandals.

16. **Parking Stands** – Allow installation of standoff bushings to accommodate elbows removed from energized connector interface and are of stainless steel.

17. **Provisions for Controller** – Options available to provide mounting ring and controller (on side of enclosure) or housed within a low-voltage compartment.

18. **Control-Power Switch** – Option allows on/off control of power to mounting ring & controller.
1. **Blind-Tapped Holes** — Provide secure location for lifting angles, which are backed with protective non-hygroscopic material to keep angles from scratching enclosure during handling and installation.

2. **Louvers** — Provide additional ventilation for enclosures in areas requiring increased air circulation.


4. **Stainless-Steel Door Handle** — Hinged cover blocks access to penta-head bolt until padlock is removed.

5. **Nameplate & Signs** — Provide pertinent unit information and optional signs for customer designations.

6. **Gasketing on Flange** — At bottom of enclosure provides protection during installation; seals enclosure bottom to pad.

7. **Ground Bus** — Flat round-edge copper bus for enclosure ground full width of door opening.

8. **Galvanized Floor Plate** — Below essential areas provide further isolation from environment, but leaves openings at grounding areas.

9. **Aluminum Bus** — Provided as standard for interconnecting components; copper bus is optional.

10. **Capacitors** — Sized to meet bank requirements with copper bus interconnecting ground bushings.

11. **Containment Reservoir** — Collection pan for any liquid leaking from damaged capacitors.

12. **Passive Door** — Secured closed with penta-head bolts and is overlapped by active door.

13. **Finish** — Standard Color is Munsell No. 7GY 3.29/1.5 Dark Green (optional colors available).

14. **Fused Voltage Transformer** — Provides control power for switched-bank controllers and operation of capacitor switches.

15. **Reactors** — One per phase to limit in-rush currents and fault current.

16. **Capacitor Switch** — Single-pole manual switching or switched bank with controller for capacitor circuits.

17. **Removable Clear Polycarbonate Barrier (optional)** — Secured to enclosure with penta-head bolts; lifts off to provide access to capacitors and VT fuses. Red GPO-3 insulating fiberglass barriers are standard.
Barriers
B6 Clear polycarbonate barriers instead of red GPO-3 fiberglass.
B7 Hinged barriers instead of lift-off barriers on dead-front side.
B8 Hinged barriers instead of lift-off barriers on live-front side.

Special Finish Color & Materials
C All Copper Bus
F2 ANSI 61 Light Gray
F3 ANSI 70 Sky Gray
F5 Coal Tar coating on lower three inches of cabinet
F6 Type 304 Stainless-steel external surfaces (door, roof, and enclosure)
F7 Stainless-steel or non-ferrous hardware, including internal mounting angles, brackets, etc. and with three-point roller latch on door replacing automatic door-latch system.
F8 All stainless steel – Combines F6 and F7

UNIT DIMENSIONS

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<th>KVAR</th>
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<td>25</td>
<td>CONSULT FACTORY</td>
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</table>

Figure 8. In this dead-front capacitor bank, the current-limiting fuses are visible through the optional clear polycarbonate barrier (suffix-B6).
HOW TO ORDER:
Federal Pacific will develop 15kV and 25kV pad-mounted capacitor banks sized to 3600 kvars. The customer is to select (1) the desired components, choosing capacitors, bushings, bushing wells, current-limiting fuses, capacitor switch, reactor, choosing from the brands listed for each component, (2) the desired optional features from those listed and, (3) whether the bank is to be manual, switched or automatic. Consult factory for alternate designs and optional features.

Pad-Mounted Capacitor Bank Catalog Number Designations:

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<tr>
<th>CB</th>
<th>Controller Required</th>
<th>Reactor Required</th>
<th>Capacitor Brand</th>
<th>Fuse Type</th>
<th>Switch Type</th>
<th>Quantity of Bushings or Bushing Wells</th>
<th>Bushing or Bushing Well Ratings</th>
<th>Total Bank KVAR</th>
<th>Quantity Code</th>
<th>Classification</th>
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<td>Y - Yes (Specify Reactor Size in Henrys in RFQ and Purchase Order)</td>
<td>A - ABB</td>
<td>L - Cooper X-Limiter Current-Limiting Fuse (Specify Ampere Rating and Part Number in RFQ and Purchase Order)</td>
<td>T - Oil Switch — Maysteel Trinetics</td>
<td>3 - Bushings or Bushing Wells for Radial-Tap Application</td>
<td>2 - 200-Ampere Bushing Wells</td>
<td>1 — 150</td>
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<td>C - Cooper</td>
<td>N - Cooper NX Current-Limiting Fuse (Specify Ampere Rating and Part Number in RFQ and Purchase Order)</td>
<td>U - Solid-Dielectric Switch — Maysteel Ultra Vac</td>
<td>6 - Bushings or Bushing Wells for Loop-Through Application</td>
<td>6 - 600-Ampere Bushings</td>
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<td>5 — 25kV Class</td>
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<td>G - General Electric</td>
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</table>
Federal Pacific Metal-Enclosed Wall-Mounted Fuse Cabinets provide a safe, convenient method of fusing loads where switching is not required or is done elsewhere. These space-efficient cabinets may be wall or floor mounted and may be located in dry indoor vaults or outdoors. Typical applications include protection of:

- A transformer in an industrial or commercial building.
- A high-density load in a commercial building.
- A feeder circuit fed by a selector switch, manual or automatic.

Wall-mounted fuse cabinets are available for three-phase applications on 15 kV and 25 kV systems.

Indoor/outdoor design: All welded, 11-gauge steel with gasketed doors (on outdoor units), three-point door latches, screened rainproof louvers and padlockable handle. The anti-corrosion finish system includes chemical cleaning, phosphatizing (or zirconization) and sealing followed by an electrostatically deposited powder epoxy primer. The finish coat is an electrostatically deposited polyester topcoat. The finish system meets the requirements of ANSI C57.12.28 and the standard color is ANSI 61 light gray.

**Cable Termination Options:**

- Knockouts for conduit.
- Porcelain flange mounted potheads.
- 200-ampere bushing wells for loadbreak inserts and elbows, 15kV, 95kV BIL and 25kV, 125kV BIL.
- 600-ampere bushings for non-loadbreak type separable connectors 15kV, 95kV BIL and 25kV, 125kV BIL.
Wall-Mounted Cabins

Exterior of Wall-Mounted Fuse Cabinet.

Wall-Mounted Fuse with door open to show optional internal dual-purpose barrier system.

Federal Pacific load-break fuse mountings are equipped with a Positive-Latch Indicator displaying a target when the fuse is completely latched, ready for the next load-break (opening) operation. Do not leave fuse in an unlatched condition. Label on inside of door displays latched condition.

Label showing fuse latched condition.

SML-4Z fuse holder with 200 ampere Auto-jet load-break fuse mounting. Other fuse types are available.

Label showing ratings of fuses, system diagram and manufacturing data.

Dual-purpose barrier for each fuse position.

Posiive Latch Indicator.

View Showing Various Positions for Optional Dual-Purpose Fuse Barriers.
(Shown with SML-4Z fuseholders)

View With Door Open and Barriers Removed.
(Shown with SML-4Z fuseholders)
INDOOR/OUTDOOR SPECIFICATIONS
(Illustrated with optional porcelain terminators)

Section View Loop Feed with Non-Loadbreak Fuse

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<td>17.0</td>
<td>95</td>
</tr>
<tr>
<td>WMF-315-93-U20</td>
<td>13.8</td>
<td>17.0</td>
<td>95</td>
</tr>
<tr>
<td>WMF-325-63-U20</td>
<td>25</td>
<td>27 125</td>
<td>200E</td>
</tr>
<tr>
<td>WMF-325-93-U20</td>
<td>25</td>
<td>27 125</td>
<td>200E</td>
</tr>
</tbody>
</table>

† Dimensions are not to be used for construction purposes.
* These are non-loadbreak units designed to accept the type SM-4 fuseholder.
** The Auto-jet loadbreak integral interrupter is included in these units, accepting either the SML-4Z fuseholder, the SMU-20 fuse with SML-20 end fittings, or DBU fuses and end fittings. The Auto-jet device permits live switching up to 200 amperes with an ordinary hotstick.
Wall-Mounted Switch Cabinets
15kV • 25kV

The Federal Pacific Wall-Mounted Switch Cabinets include the Federal Pacific Auto-Jet® II Load-Interrupter Switch in a space efficient, all-welded, Indoor/Outdoor 11-gauge steel enclosure designed for wall or floor mounting (with optional floor stand). Mounting tabs are included on the back at the top and bottom. Lifting eyes are provided on the sides at the top. Holes with removable plates are provided in the top and bottom for conduit entrance.

The enclosure door is secured at three points - two pentahead bolts and a padlockable tab - and has stainless-steel hinges and pins. A three-point latching design with a lockable handle is also available.

A window barrier is provided in the interior to allow viewing the position of the switch blades when optional dual-purpose barriers are in the normal hanging position. Louvers are installed in the door to ensure proper ventilation. The door opening is gasketed at top and on both sides for outdoor applications.

The anti-corrosion finish system includes chemical cleaning, phosphatizing, followed by a powder epoxy primer. The finish coat is an oven-baked, powder polyester finish. Standard color is ANSI 61, light gray.

The Auto-Jet® II Load-Interrupter Switch used in Federal Pacific Wall-Mounted Switch Cabinet is rated 600 amperes, 15 kV, is UL® Recognized and features an industry-leading, 3-time duty-cycle fault closing rating of 40,000 amperes asymmetrical.

Typical applications include:
- Service Entrance Switching
- Transformer Primary and Secondary Switching
- Line Switching
- Load Switching
- Loop Switching

Figure 1, Indoor/Outdoor Switch Cabinet
Wall-Mounted Cabinets

Exterior view of rugged Federal Pacific wall-mounted switch enclosure.

Interior view of wall-mounted switch to show barrier arrangement.

Interior view of wall-mounted switch to show Auto-jet® II switch.
Metal-Enclosed Switchgear

Around industrial plants, universities, waste water treatment facilities, convention centers and similar other large facilities usually there is a need to distribute electrical power located below the ground surface at medium voltage (5kV - 38kV) via cable circuits. Typically, these circuits are connected to a central assembly of switchgear, fed by a main circuit from the local utility, and arranged in lineups of multiple cubicles.

There are basically two types of Medium-Voltage (MV) Switchgear lineups: Metal-Clad (containing drawout circuit breakers) and Metal-Enclosed (containing load-break switches and fuses). The fuses used in Metal-Enclosed equipment can be either expulsion or current-limiting. Figure 1 represents the relative energy-limiting capabilities of MV breakers, expulsion fuses and current-limiting fuses, which in the case of Metal-Enclosed Switchgear utilizes expulsion and current-limiting fuses for protection to provide the best energy limitation.

These two types of medium-voltage switchgear lineups of cubicles are defined in ANSI Standards (C37.20.2 for Metal-Clad and C37.20.3 for Metal-Enclosed). Criteria for selecting one of these two types of switchgear should be: security, ease of operation, the quality of protection offered, first cost and life-cycle cost.

### Metal-Enclosed Switchgear - Advantages

<table>
<thead>
<tr>
<th>Let-through energy (I^2t)</th>
<th>FOR 40KA RMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIRCUIT BREAKER (5 cycle)</td>
<td>133 x 10^6 A^2 Sec</td>
</tr>
<tr>
<td>EXPULSION FUSE (1/2 x 1 cycle)</td>
<td>20 x 10^6 A^2 Sec (Average)</td>
</tr>
<tr>
<td>CURRENT-LIMITING FUSE (200A)</td>
<td>1 x 10^6 A^2 Sec (Typical)</td>
</tr>
</tbody>
</table>

Figure 1. The dark area under each curve represents the relative energy limitation of damaging let-through currents provided by various protective devices. The curves illustrate that fuses allow through much less damaging let-through currents and, therefore, do a much better job of protecting cables and transformers.
Figure 2 below is a summary table of features favoring the selection of Metal-Enclosed lineups with switches and fuses:

While Metal-Enclosed Switchgear using load-interrupter switches and fuses has many economic and protective advantages over Metal-Clad using circuit breakers, Federal Pacific, whose predominant construction is Metal-Enclosed, will use a drawout circuit breaker to handle high, continuous load-currents that exceed the fuse rating of a switch and fuse combination or for automatic reclosing. Since faults on industrial power systems are almost always “permanent”, automatic reclosing is not desirable because subsequent reclosing will only cause further damage to cables and equipment. Thus, Metal-Enclosed switchgear lineups are the better choice.

### Advantages of Metal-Enclosed over Metal-Clad

- Lower Initial Cost per cubicle (Metal-Enclosed = 1/3 of Metal-Clad)
- Better protection for cables and transformers
- Significantly lower let-thru currents (mechanical energy)
- Significantly lower let-thru I^2 T (thermal energy)

(Repeaters take 5 cycles from relay sensing to circuit interruption. Power fuses require no more than 1 cycle for circuit interruption.)

- Lower installation cost (simple field assembly)
- No auxiliary power or VTs are needed
- No maintenance required for fuses
- No possibility of reclosing on a fault with fuses
- Single-phase protection: Shunt trip of three-phase switch in feeder cubicle when a fuse operates

---

### Dimensions for Federal Pacific Metal-Enclosed Switchgear

<table>
<thead>
<tr>
<th>Voltage Class</th>
<th>Type of O.C. Protection</th>
<th>Width (in inches)</th>
<th>Height (in Inches)</th>
<th>Depth (in Inches)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Manual</td>
<td>Motor Operated</td>
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<tr>
<td>5kV</td>
<td>Current Limiting</td>
<td>36</td>
<td>36</td>
<td>90</td>
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<tr>
<td></td>
<td>Draw-out VCB</td>
<td>36</td>
<td>—</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
<td>41</td>
<td>41</td>
<td>90</td>
</tr>
<tr>
<td>15kV</td>
<td>Current Limiting</td>
<td>36</td>
<td>36</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Draw-out VCB</td>
<td>36</td>
<td>—</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
<td>41</td>
<td>41</td>
<td>90</td>
</tr>
<tr>
<td>25kV</td>
<td>Current Limiting</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
<td>48</td>
<td>53</td>
<td>120</td>
</tr>
<tr>
<td>35kV</td>
<td>Current Limiting</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
<td>60</td>
<td>60</td>
<td>130</td>
</tr>
</tbody>
</table>

Dimensions are for standard production products.

Add 5.5 inches to the height for Outdoor NEMA 3R enclosures.

If rear-entry compartment is needed, increase the depth of the compartment by the following dimensions:

- 5 kV - add 16 inches
- 15 kV - add 16 inches
- 25 kV - add 24 inches
- 35 kV - add 30 inches
Metal-Enclosed Switchgear Application

Federal Pacific Metal-Enclosed Load-Interrupter Switchgear provides a secure, convenient method for switching and overcurrent protection of high-voltage cable systems. The switchgear may be located indoors or outdoors. Typical applications include:

- Service entrance switching.
- Transformer primary and secondary switching.
- Isolation and protection of feeder circuits.
- Loop circuit sectionalizing.
- Manual and automatic transfer from preferred to emergency circuits.

Federal Pacific Metal-Enclosed Switchgear has been designed to meet the most rigid requirements for this class of equipment. High-grade 11-gauge steel panels are designed so that each switchgear bay is an individual self-supporting unit with double walls between bays on multiple bay lineups.

Corrosion-resistant cabinets are assured by chemical cleaning and phosphatizing (or zirconization) followed by a rust-resistant baked powder epoxy prime coat followed by a baked-on polyester finish coat that is UL® Listed for NEMA1 and NEMA 3R installations. Powder coats are applied using electrostatic deposition. Standard color is light gray, ANSI 61.

The Auto-Jet® II load-break switch is equipped with a quick-make, quick-break stored-energy mechanism. The operating handle is mounted on the right front of the unit at a convenient level with a maximum upward swing of 78" above ground level. The maximum operating force is 60 pounds. The standard manual operating handle may be padlocked either open or closed. A mechanical interlock is provided as standard to prevent opening the door with the switch closed or closing the switch with the door open. Optional key interlocks to replace mechanical interlocks as well as other key-interlock systems are available. Inspection windows are located so that the position of the switch blades may be checked with the exterior bulkhead door closed.

Standard switchgear main bus is rated 600 amperes, 40,000 asymmetrical rms amperes momentary. Optional main bus rating of 1200 amperes is available to 61,000 asymmetrical amperes momentary.

### Applicable Industry Standards

| ANSI C37.22 | Preferred Ratings and Related Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear |
| ANSI C37.3 | Requirements for High-Voltage Air Switches |
| ANSI C37.32 | High-Voltage Switches, Bus Supports, and Accessories – Schedules of Preferred Ratings, Construction Guidelines, and Specifications |
| ANSI C37.34 | Test Code for High-Voltage Air Switches |
| ANSI C37.57 | Metal-Enclosed Interrupter Switchgear Assemblies – Conformance Testing |
| ANSI C37.58 | Indoor AC Medium-Voltage Switches for use in Metal-Enclosed Switchgear – Conformance Test Procedures |

### Switch Ratings

<table>
<thead>
<tr>
<th>Nom.</th>
<th>Max. Design</th>
<th>Continuous &amp; Interrupting</th>
<th>Momentary RMS ASYM</th>
<th>Fault-Closing RMS ASYM</th>
<th>BIL kV</th>
<th>60 Hz Withstand kV</th>
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<tbody>
<tr>
<td>4.8</td>
<td>5.5</td>
<td>600</td>
<td>40,000</td>
<td>40,000</td>
<td>60</td>
<td>19</td>
</tr>
<tr>
<td>4.8</td>
<td>5.5</td>
<td>1200</td>
<td>40,000</td>
<td>40,000</td>
<td>60</td>
<td>19</td>
</tr>
<tr>
<td>14.4</td>
<td>17.0</td>
<td>600</td>
<td>40,000</td>
<td>40,000</td>
<td>95</td>
<td>36</td>
</tr>
<tr>
<td>14.4</td>
<td>17.0</td>
<td>1200</td>
<td>40,000</td>
<td>40,000</td>
<td>95</td>
<td>36</td>
</tr>
<tr>
<td>14.4</td>
<td>15.5</td>
<td>1200</td>
<td>61,000*</td>
<td>61,000*</td>
<td>110</td>
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<td>1200</td>
<td>40,000</td>
<td>40,000</td>
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<tr>
<td>34.5</td>
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<td>600</td>
<td>40,000</td>
<td>40,000</td>
<td>150</td>
<td>80</td>
</tr>
<tr>
<td>34.5</td>
<td>38</td>
<td>1200*</td>
<td>61,000</td>
<td>40,000</td>
<td>200</td>
<td>60</td>
</tr>
</tbody>
</table>

1 The Auto-jet® Switch has a three-time fault-close capability at 40kA and a single-time fault-close capability at 61kA per ANSI standards.

* The switch has a 1200 ampere continuous current rating only.
Single-Bay Manual Metal-Enclosed Switchgear - Construction

Most single-bay Metal-Enclosed Switchgear is applied for the HV Switch and Fuse protection of medium-voltage industrial transformers either liquid filled or dry-type in the 500-5000 KVA range. This switchgear can be furnished in NEMA 1 and NEMA 3R construction in the cabinet security classifications of Category A, Category B or Category C.

There are two important economic considerations for selecting the design of single-bay assemblies for transformer switching applications. First, there will be considerable savings by having the switchgear cubicle “closely coupled” to the transformer primary either by flange connection or throat connection. This configuration eliminates the need for additional cable and stress relieving terminations in both the switchgear and transformer and also eliminates the need for an additional rear-entry compartment when bottom cable entry and bottom cable exit are required from a “stand-alone” cubicle.

Second, strong consideration should be given to selecting current-limiting fuses for circuit protection inside the cubicle. Current-limiting fuses provide significantly better fault energy limitation than expulsion fuses in terms of lower “peak let-thru current” (mechanical energy that deforms windings) and lower I²T energy (thermal energy that damages insulation). The initial cost of ME cubicles housing current-limiting fuses is about 25% less than ME cubicles housing expulsion fuses, which during operation can leave significant residue on insulating barriers and cabinet walls.

Exterior view of an outdoor, Category A, single-bay 15 kV metal-enclosed switchgear enclosure containing an Auto-jet®II load-interrupter switch with power fuses.

1. Lifting angles, at top of enclosure (shown on next page) are removable with bolt holes blind-tapped.
2. Screened ventilation perforations include an internal backup plate.
3. Weather sealant between roof and enclosure and between bus extension cover plate and enclosure.
4. Heavy-gauge steel cover plates over main and ground bus openings.
5. Security cover (optional) over viewing window is hinged and padlockable for Category A installations.
6. Security cover (optional) over switch operating handle can be positioned over handle in either the open or closed position and is padlockable in either location for Category A installations. Lower location shows bottom position of cover when switch handle is in open position.
7. Door handle is recessed, includes penta-head bolt and is padlockable. (Category A only).
8. Channel base of heavy-gauge steel supports enclosure of outdoor units only.
9. Stainless-steel door hinges and pins ensure easy movement of doors throughout equipment life.
10. Windows of a polycarbonate material are weather-sealed using gasketing and sealants on outdoor units.
11. Three-Point high-strength door latches and door rods.
12. Backup plate for ventilation openings on outdoor units.
13. Storage box for replacement fuses.
15. Gasketing around enclosure entry on outdoor units compresses against back of door when closed to prevent water entry.
16. Sturdy internal screens provide a second barrier to shield against accidental contact and perforated to allow visual inspection.
17. Door interlock prevents access to fuses unless switch is open.
18. Sturdy operating handle with cast-aluminum housing includes provisions for padlocks and key interlocks.

Enclosure door is open to show internal screens with openings for viewing switch position and blown-fuse indicators.
1. Main bus is rated for 600 amperes, 1200-ampere bus is also available.

2. Auto-Jet® load-interrupter switches, rated 600 and 1200 amperes, are UL® recognized and feature an industry-leading three-time duty-cycle fault-closing rating of 40,000 amperes asymmetrical and a one-time duty-cycle fault-closing rating of 61,000 amperes asymmetrical.

3. Unit can be furnished with a variety of power fuses which are current-limiting or expulsion fuses.

4. Ground studs on fuse terminal and provisions on ground bus.

5. GP0-3 fiberglass barriers isolate phases and ground plane.

6. Heater in fused circuit inside outdoor units (not visible on sidewall of enclosure).

Door and screens open showing clear space for terminating cables and replacing fuses.
Features (Single-Bay & Multi-Bay)

- Standard doors are full height. Inner screen doors control access to fuses and other energized components.
- Metering transformers may be located in switch-fuse compartment or may be located in a separate adjacent compartment.
- Switch position can be seen through sealed, clear polycarbonate window and perforated inner screen.
- Bulkhead doors feature 3-point latching, a captive hex-head security bolt, padlockable flush mounted handle, self-latching doorstop and stainless steel concealed hinges. Category A security features are available as an option.
- Switch handles have provisions for padlocking in the opened or closed positions and can accommodate a Portable Remote Operating Mechanism (see optional features).
- Standard ventilation louvers are included at top and bottom on front and back of each bay. All louvers on outdoor assemblies are tamper resistant and have internal screens with filters.
- Mechanical interlock prevents opening door with switch closed or closing switch with door open.
- Bus bars are aluminum (copper optional).
- Ground bus in each compartment is aluminum (copper optional).
- Hinged inner steel door guards against contact with the switch and is perforated to allow view of switch blades.
- "Danger — High Voltage" signs are located on inside on screen doors.
- Rear access is not required except to accommodate special entrance requirements.
- Fuses may be current limiting or expulsion type with exhaust control devices.

Outdoor Units (NEMA 3R)

- Roof weather sealed to enclosure.
- Adjacent bays are sealed to keep water out from between the double walls.
- Roof caps over joints between bays are provided as an added measure to exclude water.
- A space heater (on a fused circuit) in each unit eliminates excessive condensation.
- Externally removable filters provided with outdoor features.
- Formed steel channel base on each individual unit has an insulating coating applied.
- Underside of all roofs have a heavy coat of anti-condensation compound.

Optional Features and Accessories

- Portable Remote Operating Mechanism - fits over manual handle and allows switch to be opened or closed from outside the arc-flash boundary.
- Mimic Bus
- Single-Phase Protection
- Blown Fuse Indication
- Analog or Digital Customer Metering
- Utility Metering
- Drawout VTs or CPTs
- Undervoltage Trip
- Overvoltage Trip
- NEMA 3R Enclosure
- UL Listing (5 and 15kV)
- Station, Intermediate and Distribution Class Surge Arresters
- Key Interlocks
- Motor Operator, Auxiliary Switches, Operation Counter
- Current Transformers
- Special Paint
- Special Enclosure Material (304 or 304L Stainless Steel)
- Close Coupling to Transformers, Existing Switchgear, or Retrofit
Federal Pacific has developed a portable remote operating mechanism (PROM) that can be applied for operation of manually-operated Auto-jet® switches from a location outside the critical arc-flash boundary zone. The fittings required to accommodate the portable mechanism can be retrofitted onto switchgear already installed in the field. Alternately, the fittings can be provided as an option on new switchgear.

Designs of the Federal Pacific PROM Portable Mechanism are available for operation of Auto-jet® switches rated through 38kV on both metal-enclosed switchgear and pad-mounted switchgear. The portable remote operating mechanism is capable of opening and closing the switch from a distance of up to 50 feet.

**Features:**

1. Extendable 50-foot Air Hose With Fast-On Pneumatic Coupler for Connection to An Air Cylinder and CO₂ Tank
2. Gusseted Mounting-Frame Weldment of Portable Mechanism
3. Ring Bushing With Set Screw Secures Operating Lever to Switch-Operating Handle
4. Lifting Eyes (2)
5. Operating Lever of Portable Mechanism
6. Handle Grip for Portable Operating Station
7. Portable Operating Station Holds Portable Mechanism and CO₂ Tank
8. Shield Isolates Chain-Drive Assembly
9. Mounting Bolts (2) Secure Portable Mechanism Onto Portable Operating Station
10. Air Cylinder With Fast-On Pneumatic Coupler for Connection of An Air Hose
11. Optional Two-Wheel Dolly is Permanently Secured to Portable Operating Station
12. CO₂ Tank, 15 lbs., Provides Approximately 150 Operations
13. Bottom of Portable Operating Station is Formed With a Channel Base to Readily Accommodate a Two-Wheel Dolly When That Option is Not Selected
This checklist is an aid to establish the desired configuration of metal-enclosed switchgear. This page can be used as a guide of what is to be furnished.

These pages contain information for defining the entire lineup and for setting the contents of each bay in the lineup. Insert in the space below each bay the cubicle number shown on “page 132”. The cubicle number and the information in the 'Unit Requirements' matrix (below) will allow a clear understanding of what is to be furnished.

There are two basic metal-enclosed switchgear arrangements. One is a single-bay transformer primary that is almost always used for a fused HV switch connected to a liquid-filled or dry-type transformer, or can add-on bay to an existing switchgear assembly. It is suggested that this single cubicle be attached (closely coupled or throat connected) to a transformer to eliminate costly extra terminations and rear cable entry compartment needed for “bottom cable entry” and “bottom cable exit” in the same cubicle.

The second type of switchgear arrangement is a multi-bay lineup containing two (2) or more cubicles. Within this type of arrangement there are several basic types of cubicles:

- Incoming (sometimes fused)
- Feeder (almost always fused)
- Transition (main bus is redirected from a top routing to a bottom routing or vice versa)
- Metering (includes current and voltage transformers)

Regarding cubicles with fuses, Federal Pacific recommends that current-limiting fuses be selected wherever possible for better energy limiting protection without the exhaust gases typically associated with expulsion fuses, whose pressures are contained by the cubicle and whose arcing products are de-ionized through an exhaust control device. Cubicles with current-limiting fuses have a significantly lower initial cost than expulsion fuses.

For Incoming Cubicles connected to circuits at 15 kV that are above 400 continuous load amperes, Federal Pacific offers the choice of a metal-clad drawout vacuum circuit breaker that contains in a single module all of the CTs, relays, etc. necessary for operation, and which can be provided with a UL® listing in a standard 36” wide x 90” high cubicle or parallel arrangements of expulsion fuses, which require bays of up to 60 inches in width. Current-limiting fuses can be used in Incoming Cubicles at 5kV up to a continuous ampere rating of 1100 amps.

### Unit Requirements - Applies to the entire lineup

<table>
<thead>
<tr>
<th>System Voltage: ___________________ Volts</th>
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</thead>
<tbody>
<tr>
<td>Fusing:</td>
</tr>
<tr>
<td>☐ Current Limiting</td>
</tr>
<tr>
<td>☐ Expulsion</td>
</tr>
<tr>
<td>Enclosure:</td>
</tr>
<tr>
<td>☐ NEMA 1 (indoor)</td>
</tr>
<tr>
<td>☐ NEMA 3R (outdoor)</td>
</tr>
<tr>
<td>Bus:</td>
</tr>
<tr>
<td>☐ Aluminum</td>
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<tr>
<td>☐ Tinplate</td>
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<tr>
<td>☐ Copper</td>
</tr>
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<td>☐ Silver Plate</td>
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<td>☐ C</td>
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<td>☐ Not Required</td>
</tr>
</tbody>
</table>

Enter in space below each bay # at right applicable cubicle number from One-Line Diagrams on Page 132.

<table>
<thead>
<tr>
<th>Bay #1</th>
<th>Bay #2</th>
<th>Bay #3</th>
<th>Bay #4</th>
<th>Bay #5</th>
<th>Bay #6</th>
<th>Bay #7</th>
<th>Bay #8</th>
<th>Bay #9</th>
<th>Bay #10</th>
<th>Bay #11</th>
</tr>
</thead>
</table>

Switch (Amps) for each cubicle
Fuse (Amps) for each cubicle
Bushings between Cubicles (Y or N)
LA___________ MCOV_________ (Y or N)
☐ Dist.  ☐ Int.  ☐ Stat.  ☐ 1-Phase Protection (Shunt Trip) (Y or N)
Power Operated (Y or N)
Automatic Transfer (Y or N)
Fast-Trip Transfer (Y or N)
Run & Trip (Y or N)
With SCADA (Y or N)
Typical One-Line Diagrams for Individual Bays of the Lineup Showing the Applicable Cubicle Number and Cubicle Description.

1. **Incoming Vacuum Circuit Breaker** for circuit protection at 15 kV of load currents greater than 400 A.
2. **Bus Entrance**, main bus top, provision for bottom entry.
3. **Switch Only**, main bus top, bottom cable entry.
4. **Switch Only**, main bus bottom, top cable entrance.
5. **Switch/Fuse**, main bus bottom, top cable entrance.
6. **Bus Transition**.
7. **Incoming Cubicle Switch/Fuse**, main bus top, bottom cable entry.
8. **Feeder Cubicle Switch/Fuse**, main bus top, bottom cable exit.
9. **Feeder Cubicle Fuse Only**, main bus top, bottom entry (or exit).
10. **Main-Bus Metering**, provisions for CTs and drawout fused PTs.
11. **Main-Bus Metering**, provisions for CTs and fixed fused PTs.
12. **Bus-Entrance Metering**, main bus top, provisions for CTs and fused PTs, bottom entry.
13. **Switch/Fuse Metering**, main bus top, provisions for CTs and fused PTs bottom exit.
14. **Bus-Transition Metering**, provisions for CTs and fused PTs.

**Typical Single Units**

1. **Switch/Fuse** top cable entrance, bottom cable exit.
2. **Switch/Fuse**, bottom cable entrance on side, bottom cable exit.
3. **Switch/Fuse** with bottom rear cable entry and with transformer transition.
4. **Switch Only**, top cable entrance, bottom cable exit.
5. **Switch/Fuse Metering**, bottom rear cable entrance, bottom front cable exit.

**Component Standard Symbols**

*Typical units with corresponding footnote symbols can accommodate the associated components.*
A. General

1. Product

The integrated metal-enclosed switchgear assembly shall be in accordance with the applicable plans, drawings and one-line diagrams and shall conform to these specifications.

2. Assembly

The metal-enclosed switchgear assembly shall consist of one or more indoor, outdoor self-supporting bays, containing interrupter switches and/or power fuses with the necessary accessory components, all completely factory assembled and operationally checked.

3. Ratings

a) Ratings for the integrated switchgear assembly shall be as designated below. Select appropriate column.

<table>
<thead>
<tr>
<th>System Voltage Class</th>
<th>5kV</th>
<th>15kV</th>
<th>25kV</th>
<th>25kV</th>
<th>35kV</th>
<th>35kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>kV, Nominal</td>
<td>4.16</td>
<td>14.4</td>
<td>24.9</td>
<td>24.9</td>
<td>34.5</td>
<td>34.5</td>
</tr>
<tr>
<td>kV, Maximum Design</td>
<td>5.5</td>
<td>17.5</td>
<td>27</td>
<td>27</td>
<td>38</td>
<td>38</td>
</tr>
<tr>
<td>kV, BIL</td>
<td>60</td>
<td>95</td>
<td>125</td>
<td>125</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Main Bus Continuous</td>
<td>600</td>
<td>1200</td>
<td>600</td>
<td>1200</td>
<td>600</td>
<td>1200</td>
</tr>
<tr>
<td>Switch Load Interrupting</td>
<td>600</td>
<td>1200</td>
<td>600</td>
<td>1200</td>
<td>600</td>
<td>—</td>
</tr>
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</table>

Short-Circuit Ratings

<table>
<thead>
<tr>
<th>Amps, RMS</th>
<th>25,000</th>
<th>38,000</th>
<th>25,000</th>
<th>38,000</th>
<th>25,000</th>
<th>38,000*</th>
</tr>
</thead>
<tbody>
<tr>
<td>MVA 3-Phase Symmetrical at Rated Nominal Voltage</td>
<td>100</td>
<td>275</td>
<td>625</td>
<td>950</td>
<td>1,000</td>
<td>1,500</td>
</tr>
<tr>
<td>Fault-Closing Amps, RMS</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Fault-Closing Amps, RMS Asym 3-Times Duty-Cycle</td>
<td>—</td>
<td>61,000</td>
<td>—</td>
<td>61,000</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Fault-Closing Amps, RMS Asym 1-Time Duty-Cycle</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

b) The manufacturer shall furnish upon request certification of ratings for the basic switch and fuse components and/or the integrated metal-enclosed switchgear assembly consisting of the switch and fuse components in combination with the enclosure(s).

5. Compliance with Standards and Codes

a) ANSI C37.20.3 and IEEE Standard 27 (Standards for Switchgear Assemblies including Metal-Enclosed Bus).

b) Applicable safety and health standards promulgated pursuant to Federal Occupational Safety and Health Act of 1970.

c) Article 490.21(E) "Load Interrupter" in the National Electrical Code, which specifies that the interrupter switches in combination with power fuses shall safely withstand the effects of closing, carrying, and interrupting all possible currents up to the assigned maximum short-circuit rating.

d) (Optional) The switchgear assembly shall be UL listed. (Available on 5kV and 15kV switchgear only.)

B. Construction — Assembly:

1. Insulators

The interrupter-switch and fuse-mounting insulators shall be a cycloaliphatic epoxy resin system with material characteristics and restrictions as follows:

a) Operating experience of at least twenty (20) years under similar conditions.

b) Ablative action to ensure non-tracking properties.

c) Adequate leakage distance established by test per IEC Standard 60507.

d) Adequate strength for short-circuit stress established by test.

e) Conformance with applicable ANSI and IEEE standards.

f) Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the metal-enclosed gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2. High-Voltage Bus

a) Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

b) Bolted aluminum-to-aluminum connections (copper is optional) shall be made with a suitable number of non-corrosive bolts and nuts, and with two Belleville spring washers per bolt, one under the bolt head and one under the nut or with a wide, flange-head carriage bolt and one Belleville spring washer per bolt. As an alternate, bolted aluminum-to-aluminum connections shall be made with a suitable equivalent surface area, i.e. L-bolt and spring washer. Bolts shall be tightened to proper torque for the particular Belleville washer.
3. Ground Bus
   a) A ground bus of short-circuit rating equal to that of the integrated assembly (or a ground connection, in the case of single-bay switchgear) shall be provided, maintaining electrical continuity throughout the integrated assembly.
   b) The ground bus shall consist of aluminum bar of 56% IACS conductivity.
   c) In each bay, the ground bus (or connector) shall be bolted to a stainless steel bracket, which shall be welded to the enclosure (copper is optional).

C. Construction - Enclosure & Finish

1. Enclosure
   a) The enclosure of each bay shall be constructed of heavy-gauge formed steel panels that maximize strength, minimize weight, and inhibit internal corrosion. (Optional all welded construction is also available.) For Category A only: externally removable bolted panels will not be accepted unless specified and when specified must be installed with tamper-resistant hardware.
   b) The basic material for the enclosure, roof and doors shall be 11-gauge, hot-rolled, pickled-and-oiled steel sheet.
   c) Each bay containing high-voltage components shall be a complete unit in itself, with full side sheets resulting in double-wall construction between bays. To guard against unauthorized or inadvertent entry, side and rear sheets shall not be externally attached with removable bolts except where tamper-resistant hardware is specified.
   d) Sufficient space shall be allowed for ease of cable pulling and installation. Space shall be free from fixed structural members or electrical devices.
   e) On multi-bay units when “thru-bushings” between the cubicles are specified, the thru-bushings should be shipped completely assembled to the cubicle and shall not require field assembly of semi-conducting grommets.

2. Doors
   a) Doors shall be constructed of 11-gauge hot-rolled, pickled-and-oiled steel sheet.
   b) Door edge flanges shall overlap with door opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects.
   c) Doors shall have an appropriate number of hinges based on door height and, in no case, less than three when door height exceeds forty (40) inches. The hinges and hinge pins shall be stainless steel and secured in place to guard against tampering.
   d) In consideration of controlled access and tamper resistance, each door shall be equipped with a positive-action three-point latching system.
   e) Doors providing access to fuses shall have provisions to store spare fuse units or refill units.
   f) Each door is provided with a door holder to hold the door open against inadvertent closing. It shall be integral with the door and frame and shall self-secure when the door is fully opened.
   g) Each door shall be provided with a recessed stainless-steel door handle. The door handles shall be padlockable and shall incorporate a hood to protect the padlock shackle from tampering. Each handle shall be provided with a recessed (select the hex or penta-head) bolt for additional security.

3. Access Control
   a) Doors providing access to interrupter switches with power fuses shall be mechanically or key interlocked to guard against:
      1) Opening the door if the interrupter switch on the source side of the power fuse is closed, and
      2) Closing the interrupter switch if the door is open.
   b) Doors providing access to interrupter switches only shall have provisions for padlocking.
   c) Each bay or compartment thereof containing high-voltage components shall be provided with a protective screen or second door, bolted closed, to guard against inadvertent entry to bays containing these components when the enclosure door is open.
   d) Access to the enclosure shall be from the front only, unless otherwise specified (for example) for cable termination at rear.

4. Vents
   Ventilation openings shall be provided at the top and bottom of the unit as required for proper air circulation. Vents shall have stainless steel screened interior baffles to prevent entrance of foreign objects.

5. Lifting Eyes
   Lifting provisions shall be removable and shall not permit entry into the interior when removed.

6. Finish
   a) Full coverage at joints and blind areas shall be achieved by processing enclosure panels or welded enclosures independently of components such as doors and roofs before assembly into the unitized structures.
   b) All surfaces shall undergo a chemical cleaning, phosphatizing or zirconization and sealing before any protective coatings are applied in order to remove oils and dirt, form a chemically and anodically neutral conversion coating, improve the finish-to-metal bond, and retard underfilm propagation of corrosion.
   c) The finishing system shall be applied without sags or runs for a pleasing appearance.
   d) After the enclosure is completely assembled and the components (switches, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be carefully touched up to restore the protective integrity of the finish.
   e) Unless otherwise specified, the color shall be ANSI 61 Light Gray.
   f) To assure that the finishing system is capable of resisting corrosion, the manufacturer shall provide if requested certification that representative test panels, protected by the manufacturer’s finish system, have passed the following tests:
      1) Salt spray (relates to coastal environments and/or presence of snow-melting salts or fertilizers). Scribe to bare metal and test for 2000 hours in a 5% salt spray per ASTM B-117. Loss of adhesion from bare metal
should not extend more than 1/8" from the scribe. Underfilm corrosion should not extend more than 1/16" from the scribe.

2) Crosshatch adhesion (relates to adhesion after scratching of the finish). Scribe to bare metal a crosshatch pattern of 100 1/16" wide squares. Apply Scotch 710 tape and rapidly remove. There should be 100% adhesion to the bare metal and between layers.

3) Humidity (relates to environments with high humidity). Test for 1000 hours subject to 100% humidity at 45-50°C per ASTM 2247. There should be no blisters.

4) Impact (relates to transit and handling damage and abuse by public). Impact the test panel with a 160 in.-lb., falling dart per ASTM D-2794. There should be no cracking or chipping of the paint on the impact side of the test panel.

5) Oil Resistance (relates to probable contact with mineral oil). Immerse two test panels in mineral oil for 3 days, one at room temperature and one at 100°C (212°F). There should be no apparent changes, such as color shift, blisters, loss of hardness or streaking.

6) Ultraviolet Accelerated Weathering Test (Relates to exposure to sunlight and rainfall, loss of gloss, color fading, and chalking). Continuous exposure to ultraviolet light for 500 hours per ASTM G-53 with a cycle of 4 hours ultraviolet followed by 4 hours of condensation. Loss of gloss should not exceed 50% of original gloss per ASTM D-523.

7) Water Resistance (relates to rainfall or dew). Immerse a test panel in distilled water for 3 days at room temperature. There should be no apparent changes, such as blistering, color shift, loss of hardness or streaking.

8) Adhesion—Fed Spec. 141A, Method 6301.1 (relates to adhesion after scratching the finish). Immerse test panel in distilled water for 24 hours. Make two parallel scratches 1" apart. Apply Scotch 710 tape and rapidly remove. There should be 100% adhesion to the bare metal and between layers.

9) Abrasion Test — Taber Abrader (relates to wear encountered during installation). Prepare a panel coated with the component of the finish intended to provide abrasion resistance. Test using a CS-10 wheel, 1000 gram weight, 3000 cycles, per Fed. Spec. 141, Method 6192. This provides a comparative test between samples.

g. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of nonferrous materials, galvanized, or zinc chromate plated ferrous materials. Cadmium plated ferrous parts shall not be used.

D. Basic Components:

1. Interrupter Switches

a) Interrupter switches shall have a three-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the integrated switchgear assembly. These ratings define the ability to close the interrupter switch either alone (un-fused) or in combination with the appropriate fuses three times against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum design voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

b) Interrupter switches shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame.

c) Interrupter switches shall be provided with contact blades and interrupters for circuit closing, including fault-closing, continuous current carrying, and circuit interrupting. Interrupter switches with auxiliary blades shall not be permitted.

d) Interrupter switches shall be positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence.

e) Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of correct switch position.

f) Each interrupter switch shall be provided with a switch operating handle. The handle shall be non-removable, and provisions shall be provided for padlocking in open or closed position.

g) Interrupter switches shall utilize a quick-make, quick-break mechanism installed by the switch manufacturer. The quick-make, quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the speed of the switch operating handle.

2. Fuses

a) Fuses shall be solid-material power fuses or current-limiting fuses as specified by the equipment purchaser.

b) Each bay containing fuses shall be equipped with grounding provisions on the load side of the fuses and on the ground bus.

3. Metering

a) Primary-metering compartment shall be provided as required.

b) Access to metering compartment shall be provided with a protective screen or second door, bolted closed to guard against inadvertent contact with energized parts when the main enclosure door is open.

c) Metering transformers shall be mounted such that established electrical clearances are maintained.

d) All low-voltage wiring shall be located as required to minimize exposure to high voltage.

E. Labeling

1. Hazard-Alerting Signs & Labels

a) All external doors and hinged bolted panels providing access to high voltage shall be provided with suitable hazard-alerting signs.

b) All internal screens or doors providing access to high voltage shall be provided with “Danger” signs.

c) All internal screens or doors providing access to interrupter switches shall be provided with danger signs indicating “Switch Blades May Be Energized in Any Position”.

d) All internal screens or doors providing access to fuses shall be provided with danger signs indicating “Fuses May Be Energized in Any Position”.

2. **Nameplate, Ratings Labels, & Connection Diagrams**

   a) The outside of a single or multi-compartment switchgear assembly shall be provided with a nameplate indicating the manufacturer’s name, catalog number, date of manufacture, and serial number.

   b) The inside of each door shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).

   c) A one-line connection diagram showing interrupter switches, fuses, bus, and auxiliary equipment shall be provided as a drawing with each switchgear assembly.

3. **Operating Assurance Tests**

   Each switch shall be operated mechanically and tested to verify:

   a) That the switch position indicators and contacts are in correct position for both open and closed positions.

   b) That the unit circuit configuration is shown correctly.

4. **F. Accessories**

   1. Fuse units or refill units, and voltage-transformer fuses for original installation and for spares shall be furnished as specified by the equipment purchaser.

   2. A fuse handling tool as recommended by the fuse manufacturer shall be furnished as specified by the equipment purchaser.

5. **G. Routine Production Tests**

   Production tests are those tests made to check the quality and uniformity of the workmanship and materials used in the manufacture of the switchgear. The unit shall meet the production tests described below, 1 through 3 inclusive.

   1. **Circuit Resistance Test**

      The purpose of this test is to verify that all load-interrupter switch contacts have been properly aligned and current transfer points have been properly assembled. The DC resistance of the current carrying circuit of each switch phase from terminal to terminal of each pole in the closed position shall be measured with current of at least 10 amperes flowing. The resistance shall not exceed a limit specified by the manufacturer.

   2. **Dielectric Tests**

      Insulation withstand tests are made of the completely assembled unit to determine the ability of the insulating materials and spacing to withstand overvoltages for a specified time without flashover or puncture.

   3. **H. Outdoor Units**

      In addition to the above requirements, outdoor units shall be provided with space heaters in each bay. The space heaters shall be enclosed within a perforated guard. Heater shall be fused and wired to a terminal block.

      The edges of the top and sides of adjacent bays shall be covered to prevent water entry. Roof and bay interface shall be covered between each bay to prevent water entry.

      For multi-bay units the roof construction shall be made with a roof cap channel where the cubicles are joined as shown in the drawing entitled Outdoor Roof Construction. (See Figure 8.)

      Louvers on outdoor units shall include backup plates with stainless steel screens.

<table>
<thead>
<tr>
<th>Power Frequency Withstand Test</th>
<th>Rated Max. Voltage, kV</th>
<th>Rated Withstand Impulse Voltage, kV</th>
<th>Production Test, kV, RMS 60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5</td>
<td>60</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>95</td>
<td>36</td>
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<td>27</td>
<td>125</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>150</td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>200</td>
<td>80</td>
<td></td>
</tr>
</tbody>
</table>
The Metal-Enclosed Switchgear must comply with the applicable sections in the following ANSI Standards:

- **IEEE C37.20.3** – IEEE Standard for metal-enclosed interrupter switchgear
- **IEEE C37.20.4** – IEEE Standard for indoor AC Switches (1kV - 38kV) for use in metal-enclosed switchgear
- **ANSI C37.22** – Preferred Ratings and Related Capabilities for Indoor AC Medium-Voltage Switches Used in Metal-Enclosed Switchgear
- **IEEE C37.30** – Requirements for High-Voltage Air Switches
- **ANSI C37.72** – High-Voltage Switches, Bus Supports, and Accessories – Schedules of Preferred Ratings, Construction Guidelines, and Specifications
- **ANSI C37.34** – Test Code for High-Voltage Air Switches
- **ANSI C37.57** – Metal-Enclosed Interrupter Switchgear Assemblies – Conformance Testing
- **ANSI C37.58** – Indoor AC Medium-Voltage Switches for use in Metal-Enclosed Switchgear – Conformance Test Procedures

**Dimensions for Federal Pacific Metal-Enclosed Switchgear**

<table>
<thead>
<tr>
<th>Voltage Class</th>
<th>Type of O.C. Protection</th>
<th>Width (in inches)</th>
<th>Height (in inches)</th>
<th>Depth (in inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5kV</td>
<td>Current Limiting</td>
<td>36</td>
<td>46</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Draw-out VCB</td>
<td>36</td>
<td>—</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
<td>41</td>
<td>46</td>
<td>90</td>
</tr>
<tr>
<td>15kV</td>
<td>Current Limiting</td>
<td>36</td>
<td>46</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Draw-out VCB</td>
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<td>—</td>
<td>94</td>
</tr>
<tr>
<td></td>
<td>Expulsion Fuse</td>
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<td>46</td>
<td>90</td>
</tr>
<tr>
<td>25kV</td>
<td>Current Limiting</td>
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<td></td>
<td>Draw-out VCB</td>
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<td>53</td>
<td>120</td>
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<tr>
<td>35kV</td>
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<tr>
<td></td>
<td>Draw-out VCB</td>
<td>60</td>
<td>—</td>
<td>130</td>
</tr>
</tbody>
</table>

**Notes for Dimensions Table:**

- Dimensions are for standard production products.
- Add 5 inches to the height for Outdoor NEMA 3R
- G&W Commutating Current-Limiting fuses are available for all voltages 5-38kV. Contact factory for dimensions.
- If Rear-Entry Compartment is needed, increase the depth of the compartment by the following dimensions:
  - 5kV: add 16 inches
  - 15kV: add 16 inches
  - 25kV: add 24 inches
  - 35kV: add 30 inches

**Figure 8. Outdoor Roof Construction with gasket between roof and enclosure flanges.**
## Power Fuses Ratings - Expulsion Type

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4.16</td>
<td>200</td>
<td>DBU</td>
<td>Cutler-Hammer</td>
<td>22,400</td>
<td>14,000</td>
<td>200</td>
</tr>
<tr>
<td>4.16</td>
<td>200</td>
<td>RBA-200</td>
<td>Cutler-Hammer</td>
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<td>237</td>
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<tr>
<td>4.16</td>
<td>200</td>
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<td>S&amp;C</td>
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<td>125</td>
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<td>SM-5</td>
<td>S&amp;C</td>
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<tr>
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<td>Cutler-Hammer</td>
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<td>Cutler-Hammer</td>
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<td>S&amp;C</td>
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<td>410</td>
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<td>Cutler-Hammer</td>
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## Power Fuses Ratings - Current Limiting

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1 Includes CLE, HLE, BHLE, and HCL medium voltage current-limiting fuses.
2 PAF® is a commutating current-limiting fuse, per ANSI C37.48.1, suitable for higher current applications, through 630A.
Federal Pacific of Bristol, Virginia offers power-operated metal-enclosed switchgear in two basic styles: Automatic-Transfer Metal-Enclosed Switchgear and Shunt-Trip Metal-Enclosed Switchgear. These two styles can be mixed within a switchgear assembly. In addition, other automatic and supervisory-control switching functions may be integrated into the two basic styles. The basic styles of Federal Pacific Power-Operated Metal-Enclosed Switchgear are discussed in the paragraphs that follow.

**Automatic Transfer**

Federal Pacific offers Automatic Source-Transfer Switchgear for those applications where alternate sources of power are essential for continued operation of critical loads. This switchgear features an automatic-transfer control relay as shown in Figure 1 on page 138, to monitor system conditions. The automatic-transfer relay is the SEL-451, which automatically initiates transfer to an alternate power source if voltage on the preferred source, reduces below a preset level.

Federal Pacific Automatic-Transfer Metal-Enclosed Switchgear combines Federal Pacific Auto-Jet® II Load-Interrupter Switches with motor operators and the SEL-451 relay. These components are all mounted within rigid, panel constructed, self-supporting enclosures. Low-voltage components, such as the source transfer control relay and motor operators, are isolated from medium voltage in the switchgear bay door or side stile. Alternately, for Fast-Trip Transfer the motor operators may be mounted on the side of the switchgear bay in secure low-voltage enclosures.

Federal Pacific offers two basic types of Automatic-Transfer motor operators: **Run & Trip** and **Fast-Trip Transfer Stored Energy**.

**Run & Trip** employs a motor operator on the shaft of the standard Auto-Jet® switch. When called to operate, the motor charges the spring of the switch in a similar manner to charging the switch manually. As the spring reaches its trip point, the switch blades operate in the direction for which the spring was charged (to open or to close). With the run-and-trip motor operators, transfer is achieved in approximately eight (8) seconds. The motor operators are mounted in the switchgear bay stile (as illustrated in Figure 2 on page 135), replacing the manual handle, and requiring no extra space.
For **Fast-Trip Transfer**, the motor operator is mounted on the side of the switchgear bay in a secure low-voltage compartment and directly coupled to the switch operating shaft. See Figure 3 on page 135. On loss of source voltage, the motor automatically charges and trips the springs of the switch mechanism and instantly trips the switches in approximately 20 cycles. To trip the switch, the motor charges and releases the spring energy, opening or closing the switch blades.

Employing **Fast-Trip Transfer**, the switch will trip faster (by high-speed revolution of the charging motor) after the open or close signal is received, rather than taking a few seconds to charge a spring as is done by the **Run & Trip** mechanism. But, the speed difference may not be a significant consideration for most applications. There are two transfer times that are significant: 1/4 cycle (5 milliseconds) and two cycles (33 milliseconds). The 1/4 cycle (5 millisecond) transfer will allow micro-processor circuits to remain powered and operational. The two cycles (33 millisecond) will allow metal halide lamps serving stadiums and arenas to stay lit. Beyond these two very short duration transfer times, there are limited advantages for the relative transfer-speed difference between **Fast-Trip Transfer** (with an approximate 20-cycle transfer time) and **Run & Trip** transfer.

**Run & Trip** has the advantage of lower initial cost where speed of operation is not an issue.

The Federal Pacific Automatic Transfer Switchgear is available in ratings through 38 kV for either indoor or outdoor installation and can accommodate a variety of power fuses – both current-limiting fuses and expulsion-type fuses. Federal Pacific automatic-transfer metal-enclosed switchgear provides automatic two-way source transfer with the ability to connect either of two utility sources (or a utility source and a standby generator) to the switchgear bus. In automatic-transfer switchgear, referred to as common-bus primary-selective systems, one incoming line switch is closed (preferred source) and the other incoming line switch is open (alternate source).

Bus-tie configurations requiring operation and control of more than two switches are also available and are referred to as split-bus primary-selective systems. In split-bus systems, two or more incoming source switches are closed each supplying power to an independent bus-section, which are separated by a normally open bus-tie switch. If power to a bus section is lost, the associated incoming source switch opens and the adjacent bus-tie switch closes, restoring power to the bus section. Federal Pacific’s core engineering staff can provide various types of other automatic or supervisory switching applications. For example, SCADA control interface is also available with automatic transfer.

**Automatic-Trip (Shunt-Trip) Applications**

The Federal Pacific Shunt-Trip Switch (UL Listing available for 5kV and 15kV applications) can be applied where there is an automatic tripping requirement in response to system deviations from normal conditions. Applications include: loss of voltage, over-voltage, incorrect phase rotation, transformer-overload and blown fuse (the most common reason).

Federal Pacific employs two very reliable methods for sensing a blown fuse, creating a single-phase condition. The first method is a conventional set of VTs connected to a Phase-Loss Relay (PMR); when sensing a loss of phase output voltage supplied by VTs, the PMR closes the contacts, which actuates the solenoid (powered by a capacitor), to trip the switch open. A switchgear bay equipped with shunt-trip capability is illustrated in the photos below.

The second method uses a current-limiting fuse blown-fuse indicator, which pushes the end of a cable to close the contact to activate the solenoid, which correlates to the PMR closing the contact in the first method. Using the blown-fuse indicator pin eliminates the need for a phase-loss relay (PMR) and is usually a lower cost method of single-phase protection. A picture of the cable assembled to the current-limiting fuse mount is shown in Figure 2 (on page 136).

Also illustrated is the Federal Pacific standard Auto-Jet® II switch equipped with the shunt-trip solenoid and latch module (shown in Figure 3 on page 136) and an auxiliary switch with contacts for remote indication.

Pictured above are typical feeder bays with automatic-trip (shunt-trip) switches, providing feeder isolation when a single-phase condition (such as a blown feeder fuse) occurs.
Figure 1. Type ME Motor Operators are mounted in the switchgear stile, adjacent to the compartment door opening and allowing the enclosure width to remain at only 36 inches. Federal Pacific’s source-transfer relay is mounted on the switchgear in a separate low-voltage enclosure. As pictured above, the SEL-451 relay is mounted on the compartment door of the second bay from right.

Figure 2. Hinged, gasketed cover protects motor operator from the environment and internal heater keeps air circulating to dry the interior.

Figure 3. Automatic-transfer switchgear with Fast-Trip Transfer motor operators is pictured in the photo above. Transfer to the alternate source is achieved in approximately twenty (20) cycles.
Shunt-Trip Employing VTs With Phase-Loss Relay (PMR) for Sensing and Tripping

Operation
Charging Switch:
Before the shunt-trip switch will operate manually or electrically, it is necessary to first close the switch, then charge and latch the switch operating mechanism spring so it is ready to trip open. The switch can then be tripped open manually by pulling a knob located below the handle or electrically either automatically by detecting a phase loss or remotely by initiating a trip signal by supervisory control from a distant location, if the latter option is specified and provided.

Loss of One or Two Phases:
Upon loss of one or two phases, the phase-loss relay will pick up after the preset time delay (2, 4, 6 or 8 seconds field selectable). When the phase-loss relay contact closes, the capacitor-trip device (CTD) discharges into the shunt-trip solenoid (ST). The solenoid pulls the latch holding the previously compressed mechanism spring on the switch (refer to “Charging Switch”). The switch opens, which opens a limit-switch contact (switch-position contact), thereby turning off power to the shunt-trip solenoid. After restoring power to the affected phases, manual closing and charging is then required to reset the switch latched for the next shunt-trip operation.

Shunt-Trip Using CLF Blown-Fuse Indicator To Close The Tripping Contacts

Current-limiting fuse mountings equipped with a trip-pin actuated cable release (as pictured at left) will initiate the tripping sequence to the mechanism on the charged and latched shunt-trip switch. When the fuse operates, the blown-fuse indicator is propelled upward and protrudes through the top of the fuse. The indicator engages the trip-pin actuator to move the cable that activates the contact, which causes the solenoid on the switch frame to release the latch and thereby trip the stored-energy mechanism, opening the switch.

Three-Phase Auto-jet® II Switch Equipped with Shunt-Trip Latch and Solenoid

Shunt-trip switch pictured at left is equipped with an auxiliary switch with contacts wired to a terminal block within the switchgear. These contacts reflect switch position (open or closed), allowing the actual switch position to be determined from a remote location. They can also be wired (optionally) to allow trip-open operations to be initiated by supervisory control from a distant location.
Switch Operators for Metal-Enclosed Switchgear

Fast-Trip Switch Operator

Fast-Trip Switch Operator includes switch-position indicator, decoupling lever, decoupling indicator, operation counter, shaft to manually charge switch if control power is lost, emergency manual tripping and pushbuttons for local operation. Decoupling lever isolates switch from the switch operator so that functional testing can be performed without opening and closing the switches . . . the load circuit remains energized.

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

Run & Trip Switch Operator

The Federal Pacific automatic-transfer relay utilizes a state-of-the-art electronic controller to perform operations that are directed by settings programmed into the device at the factory and in the field. Such parametric characteristics as voltage-, current-, and time-related operating parameters are entered into the control by means of a laptop computer. The entries are readily viewed on the laptop computer screen display. Internal memory with back-up battery records events and maintains a log, allowing diagnostic capability.

Automatic-Transfer Relay Control

Federal Pacific Automatic-Transfer Metal-Enclosed Switchgear utilizes the Federal Pacific Automatic-Transfer Software Program in the SEL-451 relay. The relay monitors system conditions and automatically initiates transfer to an alternate power source if voltage on the preferred source reduces below a preset level. Federal Pacific switch operators actuate opening and closing of the Federal Pacific Auto-jet® II load-interrupter switches.

The conditions required to initiate automatic switching are field selectable and are discussed under “Field Selectable Functions” on page 138.
Field Selectable Functions

To simplify entry of this information and to permit its quick review on the laptop computer, the field-selectable functions are grouped in the “MM Transfer Settings” screen, which is accessed through the software program supplied with the switchgear.

The field-selectable functions are:

**CT Ratios** for Source 1 and Source 2

**PT Ratios** for Source 1 and Source 2

**Over-Current Enabled** — Y = Enabled; N = Disabled — Over-current Lockout is enabled or disabled

**Over-Current Level for Source 1 and Source 2** — current level above which an over-current condition exists

**Over-Current Lockout Timer** (seconds) — time the over-current exists before declaring an over-current lockout

**Source 1 Initial Transfer Delay timer** (seconds) — time after dead source is declared before a transfer is initiated when Source 1 is the preferred source

**Source 1 Return Transfer Delay timer** (seconds) — time after return of source voltage before a retransfer to the preferred source is initiated when Source 1 is the preferred source and Auto Retransfer is enabled

**Source 2 Return Transfer Delay timer** (seconds) — time after return of source voltage before a retransfer to the preferred source is initiated when Source 2 is the preferred source and Auto Retransfer is enabled

**Generator as Alternate** — Y = yes and N = no — apply Y when alternate source is a generator; otherwise apply N

**Source Paralleling** — Y = yes and N = no — apply Y when paralleling sources on Return Transfer is permitted; otherwise apply N

**Return Transfer Sequence** (Open or Closed) — select open or closed transition return on retransfer to the preferred source

**CDT** (seconds) — Generator Cool Down Timer (applicable only when the alternate source is a generator)

**Generator Stop Pulse Duration** (seconds) — Time that the generator stop contact will remain closed

**Auto Retransfer** (Y — Enabled, N — Hold for retransfer) — select automatic return on retransfer to the preferred source or hold return on retransfer to the preferred source

**Dead Source Voltage** (volts) — phase-to-neutral primary voltage required to declare a dead source

**Live Source Voltage** (volts) — phase-to-neutral primary voltage required to declare a live source

**Voltage Unbalance** (volts) — Zero sequence voltage required to declare a voltage unbalance bad source (designated as 3VO)

**Functional Status LEDs**

Additional functional status conditions for both sources are indicated by twenty-four (24) available illuminated LEDs with labels on the faceplate of the relay.
These LEDs provide indications as follows:

**Over-Current Suspend** — Illuminates when an over-current has occurred and resets off if there is no loss of source voltage

**Over-Current Lockout** — Illuminates when an over-current occurs that is followed by a loss-of-source voltage

**M1 Decouple** — Motor 1 is decoupled — Capability displays for Motor 1 whether the mechanism is decoupled from the switch (LED illuminated) or coupled (LED not illuminated) to the associated switch

**M1 No Go** — LED is illuminated when Motor 1 has malfunctioned; otherwise LED is not illuminated

**M1 Batt/Chg** — Motor 1 Battery or Battery Charger has malfunctioned — LED is illuminated when Motor 1 battery or battery charger has malfunctioned; otherwise LED is not illuminated

**M1 Cls/Opn** — Motor 1 is Closed or Open — LED is illuminated green when Motor 1 is open; illuminated red when Motor 1 is closed

**M1 Rem/Lcl** — Motor 1 is in Remote or Local — LED is illuminated when Motor 1 is remote; otherwise LED is not illuminated

**M2 Decouple** — Motor 2 is decoupled — Capability displays for Motor 2 whether the mechanism is decoupled from the switch (LED illuminated) or coupled (LED not illuminated) to the associated switch

**M2 No Go** — Motor 2 has malfunctioned — LED is illuminated when Motor 2 has malfunctioned; otherwise LED is not illuminated

**M2 Batt/Chg** — Motor 2 Battery or Battery Charger has malfunctioned — LED is illuminated when Motor 2 Battery or Battery Charger has malfunctioned; otherwise LED is not illuminated

**M2 Cls/Opn** — Motor 2 is Closed or Open — LED is illuminated green when Motor 2 is open; illuminated red when Motor 2 is closed

**M2 Rem/Lcl** — Motor 2 is in Remote or Local — LED is illuminated when Motor 2 is remote; otherwise LED is not illuminated

**Mismatch** — Motor 1 and Source Switch 1 or Motor 2 and Source Switch 2 are not in the same positions — LED is illuminated when Motor 2 is in remote; otherwise LED is not illuminated

**S1VA, S1VB and, S1VC** — Illumination of the LED establishes for the applicable Source 1 phase whether the associated source voltage is available (above minimum conditions) or, if the LED is not illuminated, that source voltage is not available (below minimum conditions) on the associated phase

**S2VA, S2VB and, S2VC** — Illumination of the LED establishes for the applicable Source 2 phase whether the associated source voltage is available (above minimum conditions) or, if the LED is not illuminated, that source voltage is not available (below minimum conditions) on the associated phase

**Interactive Soft Keys**

A grouping of twelve (12) interactive soft keys combined with status LEDs and labels allow surface selection and actuation of a number of operating choices.

The interactive soft keys that provide Local Operation capability on the faceplate of the SEL-451 relay include:

**Open/Close** keys for each source switch — Capability allows actual open and close operations of the associated switch and also illuminates an LED to display for each source the actual switch position (“Switch Open” — green or “Switch Closed” — red) of the associated switch.

**Auto or Manual** operation selection — establishes operating mode of the relay — actual mode is set by depressing the applicable soft key and status is indicated by illumination of the LED that is adjacent to the two soft keys labeled “Auto” and “Manual” in a green color, designating the present mode

**Source 1 or Source 2** selected as the preferred source — capability for each source switch to provide service as the “Preferred” source, which provides power to the load under normal conditions, or as the “Alternate” source, which provides power to the load when the preferred source is not available.

**Hold Return** — Return to preferred source — if the “Auto Retransfer” MM Setting is disabled

**Remote Enabled** — capability for units furnished with SCADA interface to position the control in “Enabled” or “Disabled” mode. The control is by default in “Disabled” mode and can only be placed in “Enabled” mode through user positioning the interactive soft key on the faceplate of the relay as indicated by illumination of the associated LED

**Reset Over-Current Lockout** — allows reset of the over-current lockout condition touch the labeled soft key to reset the control following an overcurrent lockout condition. The associated LED is flashing red when an overcurrent lockout condition exists.

**Generator Start/Stop** — enabled if the alternate source is a generator
LCD Display

A large LCD display on the faceplate of the relay will continuously and automatically scroll through ten (10) primary display points.

The primary display points include functions as follows:

- **Phase Currents** for Source 1 and Source 2
- **Phase Voltages** for Source 1 and Source 2
- **Mismatch** for Motor 1 and Motor 2 — shows whether the motor and the switch are in the same position to permit coupling
- **UPS Battery Voltage** — status of battery voltage (adequate or low)
- **Battery Charger** — Status of AC input to the battery charger
- **Faulted Phase** — Identification of the phase on which a fault has occurred
- **Permissive Generator Start** — Status of start key if the alternate source is a generator

The LCD display also supports a Main Menu screen that allows access to:

- **EVENTS Log** — provides date/time stamp on events and current/voltage at time of event
- **SET/SHEW** — Function provides the facility to edit the DATE/TIME
- **DISPLAY TEST** — Function provides the facility to perform a lamp test of all the LEDs to verify functionality of all LEDs

Figure 4. SEL-451 LCD display.
UNIT SUBSTATIONS
More than 30 Years Experience Designing & Building Transformers . . .

Advantages of Federal Pacific Unit Substations:

- Single responsibility
- Complete coordination - both mechanical and electrical
- Maximum flexibility with a wide choice of components and ratings to meet exact application requirements
- Optimum security to operators
- Modern design
- Meets all ANSI, IEEE, and NEMA Standards
- Indoor or outdoor construction
- Dry or liquid-filled transformers
- Primary voltages up to 38,000 volts
- Secondary voltages 5,000 volts or less
- Load ratings up to 10 MVA (Dry)

Planning modern, industrial, commercial, and institutional electrical systems demands serious consideration of primary voltage power distribution systems. The Federal Pacific Unit Substation is a coordinated piece of equipment designed to receive electrical power at voltages up to 38,000 volts, transform it to voltages of 5000 volts or less, and control its distribution to load areas. Federal Pacific Unit Substations follow the modern system concept of locating transformers as close as possible to areas of load concentration at utilization voltages, thus minimizing the lengths of secondary distribution cables and buses. This concept provides several basic advantages, such as:

- Reduced power losses
- Improved voltage regulation
- Improved service continuity
- Reduced likelihood of faults
- Increased flexibility
- Minimized installation expenses
- Efficient space utilization

Unit Substations, as defined herein, fall within the category of "Secondary Unit Substations," as defined in NEMA Standards.
### A. Simple Radial
- Simplest and least costly
- Easy to coordinate
- No idle sections

### B. Primary Selective Radial
Similar to simple radial, with the added advantage of spare primary incoming cable circuit. By providing a spare circuit, duration of outage due to any problem on one primary circuit, such as a cable failure, is limited.

### C. Secondary Selective
Normally operates as two electrically independent unit substations with bus-tie breaker (T) open and with approximately half of total load on each bus. In case of a failure on either primary incoming circuit, only one bus is affected, and service can be promptly restored by opening main breaker (M) on dead bus and closing tie breaker (T). This operation can be made automatic, with duration of outage on either bus limited to a few seconds. Since the transformers are not continuously paralleled, secondary fault currents and breaker application are similar to those on radial unit substations. Either transformer can be removed from service and isolated with no interruption of service on either bus by first closing the tie breaker and then opening the associated main breaker. Service continuity and substation capacity can be further improved by substituting selector type primary switches, as in B.

---

**Primary or Incoming Line Section**

Federal Pacific Unit Substations are supplied with Auto-jet® II switches with the following features:

- 600 amp continuous and interrupting
- Single and three-phase
- Front chain drive
- Side-operated direct drive
- Motor operated
- Up to 61 ka asymmetrical momentary and one-time fault-closing
- Up to 40 ka asymmetrical 3-time fault-closing
- 1200 amp continuous and interrupting, most ratings
- UL® listed designs available at 5kV and 15kV

**Configurations available:**

- Single Incoming - Radial
- Dual Incoming - Loop
Transformer Section

Primary Voltages to 34.5 kV
- Dry-Type Transformers
- Liquid Transformers

Dry-Type Transformer Features:
- 112.5 KVA through 10 MVA and above
- 2.4 kV through 35 kV class
- Standard or custom designs
- Ventilated indoor or outdoor enclosures
- 80° C, 115° C, or 150° C temperature rise
- Copper or aluminum windings
- Wide variety of options and accessories
- UL® listed designs available at 5kV and 15kV

Vacuum Pressure Impregnated (VPI) and VPI/Epoxy Shielded Transformers feature polyester coil encapsulation process plus an optional epoxy shield.

Advantages over cast-coil:
- Outstanding environmental protection
- Higher thermal overload capabilities
- Significantly lower initial cost (2/3 of cast coil)
- Reduced operational cost due to elimination of epoxy cracking
- Less weight, smaller size (25% less on a typical 1000 KVA)
- Maximum design flexibility
- Greater dielectric strength
- Short delivery due to less manufacturing process time

Low-Voltage Section

Federal Pacific Power Circuit Breaker Drawout Switchgear
- UL ratings on major components, such as switches, dry-type transformers and power circuit breakers
- Secondaries from 240 VAC including:
  - 600 volt power circuit breakers
  - 5kV - 15kV metal-clad switchgear
  - 5kV motor control centers
- Custom configurations to meet specific electrical and mechanical criteria

Accessories
Standard accessories that are easily provided are: secondary metering, including transformers, feeder metering, electrical, mechanical and key interlocking, breaker element lifting device, and an array of tripping and auxiliary functions available on the breaker elements.

Federal Pacific offers the option of dry-type or liquid-filled transformers from nationally and internationally recognized manufacturers.
Federal Pacific through its sister company Line Power Custom Solutions offers Portable Electrical Substations. These substations give operators the advantage of mobility and ease of installation. In many instances, these substations have been de-energized, moved and re-energized in one day, allowing minimum down time during the move from one location to another. All substations are custom designed to meet the customer’s needs. They may have one or two high-voltage outputs to feed separate circuits and as many low-voltage outputs as are required to provide surface power. Some may also include starters to operate motors and fans or a 120/240 volt utility circuit for an office or supply building.

Federal Pacific can offer portable and permanent electrical substations and switchgear for all types of applications. Our capability, gained through many years of experience, extends from small pump substations to large multi-skid power substations with walk-in switchgear and to trailer-mounted substations. Each substation, whether skid-mounted, fixed, or trailer-mounted is individually designed by combining the customer’s special requirements with Federal Pacific’s heavy-duty construction and attention to detail.

If you are considering new electrical equipment, contact your local Federal Pacific territory manager, manufacturer’s representative or call our factory.
The Federal Pacific Three-Phase Distribution Vacuum Circuit Breaker (DVCB) is a rugged and servicable vacuum breaker utilizing a simple straight-line operator and stored energy spring mechanism. Federal Pacific includes the following standard and optional features. Additionally, Federal Pacific specializes in accessories and ratings to meet special application requirements.

### Standard Features
- Tested to the Fault Interrupter Requirements of C37.60.
- Operation Counter
- One Relay Accuracy CT Per Phase
- Selector Switch (TRIP, CLOSE)
- DC Capacitor Tripping with Fail Safe Trip Circuit
- Heavy-Duty Gear Motor with Spring Charging Mechanism That is Electrically and Mechanically TRIP FREE
- Control Voltage: 120 VAC
- Electronic Overcurrent Relay with ANSI/IEC Time-Current Curve Selections, Ground Fault Sensing, and Time-Delay Settings
- 14-gauge NEMA 3R Cabinets
- Adjustable Height Base
- Swingout Control Panel for Maintenance
- Number Markers on All Control Wiring
- Durable ANSI #61 Gray Paint
- Thermostatically Controlled Heaters
- Visible Bottle Wear Indication
- Visible Load-Side Disconnect with Automatic Grounding

### Optional Features and Accessories Include:
- Remote Control for Trip and Close
- Extra Creep Bushings
- NEMA 12 Enclosure
- Pad-Mount Enclosure
- Stainless-Steel Cabinet and Hardware
- Extra CTs for relaying and metering
- Internal or External VTs for Phase Sequence Relaying and/or Control Power
- SCADA Terminal Points
- Zone 4 300%g Seismic Duty
- Lightning Arresters
- Cabinet Options: Colors, Powder Paint, Stainless-Steel
- Customized Protection and Control Schemes

### Standard Ratings

<table>
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<tr>
<th></th>
<th>Maximum Voltage</th>
<th>15.5 kV</th>
<th>15.5 kV</th>
<th>15.5 kV</th>
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<td>Continuous Current</td>
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<td>1200 A</td>
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<td>Interrupting Rating (Sym)</td>
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<td>20kA</td>
<td>12.5 kA</td>
<td>16kA</td>
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</table>

**Distribution Vacuum Fault Interrupter**

Three-Phase Distribution Vacuum Circuit Breakers

Type DVCB With Electronic Control

---

Tamper-Proof Pad-mount

Substation Mount
Notes
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 biodegradable 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 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.
Switchgear Components

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.

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

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

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

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 maincontact.

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.

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.

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

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.

The process from the instant the switch blade starts to move until circuit interruption is achieved takes only 5 cycles.
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-contact alignment and eliminates any problem of switch-to-enclosure alignment). 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® RATINGS

<table>
<thead>
<tr>
<th></th>
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<td>600 20 21 40**</td>
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### AUTO-JET® II RATINGS

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<td>1200 15 21 40**</td>
<td>3* 130</td>
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</table>

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.  
* The three time duty-cycle fault-closing rating means that the switch can be closed three times into faulted 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.

### AUTO-JET® SWITCH

<table>
<thead>
<tr>
<th>kV</th>
<th>Amps Cont. &amp; Load-Break</th>
<th>Catalog Number</th>
<th>DIMENSIONS - INCHES</th>
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### AUTO-JET® II SWITCH

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<th>Amps Cont. &amp; Load-Break</th>
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<th>DIMENSIONS - INCHES</th>
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</table>
**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**

---

**Application Notes for Single-Phase Auto-Jet® Switches:**

1) Hookstick-Operated Single-Phase Auto-Jet® Switches are rated for 600 amps maximum continuous current. This design is not rated for load switching.

2) Side-Operated Single-Phase Auto-Jet® Switches with spring operators are rated for 600 amps maximum continuous current and 600 amps maximum load switching.

<table>
<thead>
<tr>
<th>Type</th>
<th>kV Class</th>
<th>kV BIL</th>
<th>Catalog Number</th>
<th>Dimensions - Inches</th>
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<td></td>
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○ For side operation with handle on right.
### Side and Front Operators

#### Recommended Minimum Clearances In Inches

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<tr>
<th>15kV, 25kV, 35kV Pad-Mounted Unit Rating kV, BIL</th>
<th>Phase-to-Phase or Phase-to-Ground Without Barrier</th>
<th>Phase-to-Phase or Phase-to-Ground With Barrier</th>
<th>Energized Bus (or device) to Barrier</th>
<th>Barrier to Ground in Vicinity of Energized Bus (or device)</th>
<th>Terminator Skirts to Barriers</th>
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<tr>
<td>95</td>
<td>5-1/2</td>
<td>3'</td>
<td>1-1/4'</td>
<td>1'</td>
<td>1/2'</td>
</tr>
<tr>
<td>125</td>
<td>7-1/2</td>
<td>5'</td>
<td>2'</td>
<td>1-1/4'</td>
<td>1-1/4'</td>
</tr>
<tr>
<td>150</td>
<td>10</td>
<td>7-1/2'</td>
<td>3'</td>
<td>2'</td>
<td>2'</td>
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</tbody>
</table>

**NOTES:**

- Minimum clearance from energized parts to electrical ground without barrier.
- Phase-to-Phase or Phase-to-Ground with Barrier:
- Minimum Clearance from Energized Parts to Barrier:
- Typical Barrier to Ground in Vicinity of Energized Parts:
- Minimum Clearance from Terminator Skirts to Barriers:
- G. E. Type G Termi-matic Termination System Shown
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 SCPSSE 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 25-29 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 18-19 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 25-29 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.
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.

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


15. **Smurf™ 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.


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

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

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 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

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.

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

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
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).

We have also examined and compared the Time Current Characteristic curves of the DBU and the SMU-20. Our comparison confirms that the curves consistently match. Therefore, they can be considered equivalent substitutes as protective devices. However, system protection is a sensitive field within each utility. The decision to accept the DBU fuse unit as an equal to the SMU-20 will be made by utility protection personnel and is not a standards function. Similarly, a shift away from the SM-4 fuse unit to the DBU or SMU-20 will also be made by protection personnel.

DBU As An Alternative to SML-4Z

Another particular advantage can be gained by the users of the S&C SML-4Z power fuses that are paying a substantial cost penalty if they continue to specify that fuse. At 15Kv, the cost of the SML-4Z fuse assembly adds in excess of $1100 per PSI/II-9. At 25Kv, the cost adder to use the SML-4Z increases to over $1300 per PSI/II-9. Both are substantial potential savings that should not be ignored. Thus, purchasing personnel will be interested and can at least request that protection personnel evaluate the potential shift.

We encourage you to promote the Cutler-Hammer DBU over the SML-4Z. Many utilities have already made that conversion. Of course, FP is more competitive when the DBU is allowed. More importantly, there are significant benefits to the customer. Not only is there a large financial benefit, as just mentioned above, but several other benefits as well.

We have also examined and compared the Time Current Characteristic curves of the DBU and the SMU-20. Our comparison confirms that the curves consistently match. Therefore, they can be considered equivalent substitutes as protective devices. However, system protection is a sensitive field within each utility. The decision to accept the DBU fuse unit as an equal to the SMU-20 will be made by utility protection personnel and is not a standards function. Similarly, a shift away from the SM-4 fuse unit to the DBU or SMU-20 will also be made by protection personnel.

**DBU As An Alternative to SML-4Z**

Another particular advantage can be gained by the users of the S&C SML-4Z power fuses that are paying a substantial cost penalty if they continue to specify that fuse. At 15Kv, the cost of the SML-4Z fuse assembly adds in excess of $1100 per PSI/II-9. At 25Kv, the cost adder to use the SML-4Z increases to over $1300 per PSI/II-9. Both are substantial potential savings that should not be ignored. Thus, purchasing personnel will be interested and can at least request that protection personnel evaluate the potential shift.

We encourage you to promote the Cutler-Hammer DBU over the SML-4Z. Many utilities have already made that conversion. Of course, FP is more competitive when the DBU is allowed. More importantly, there are significant benefits to the customer. Not only is there a large financial benefit, as just mentioned above, but several other benefits as well.

1. The DBU (or SML-20) fuse assembly is lighter in weight than the SML-4Z, making for easier handling by operating personnel.
2. The DBU (or SMU-20) fuse units can be used in underground as well as overhead applications. As a matter of fact, your utility may already have the SMU-20 listed on standards for overhead applications.
3. The DBU and SMU fuses are available in the same ampere ratings and speeds as the SML-4Z fuses.
4. By using the DBU or SMU-20, the utility will insure that it receives competitive bids for its end fitting requirements, whereas a sole-source position presently exists with the SML-4Z.
5. By using the DBU or SMU-20, the utility will insure that it receives competitive bids for its fuse-element requirements, whereas a sole-source position presently exists with the SM-4Z fuse elements.
6. The availability of two fuses also will allow users to receive a more competitive bid for its padmounted switchgear because the fuse pricing will not mask the price of the switchgear.
7. Many utilities have already made the conversion.
8. The DBU (or SMU-20) has somewhat higher interrupting ratings, 22,400 amperes at 15 Kv compared to the SM-4, which has only a 20,000 ampere rating at 15 Kv.

Cost savings are an important part of an employees evaluation at nearly every utility. With the above proposal, you can play an important role in supporting that evaluation goal. Make sure you present this potential advantage to customers.
### Application Data — Non-Loadbreak Disconnect

<table>
<thead>
<tr>
<th>Fuse Manufacturer</th>
<th>Fuse-Unit or Refill Unit Type</th>
<th>Mounting (Including Live Parts) Catalog No. *</th>
<th>Ratings</th>
<th>Holder or End Fittings Catalog No. **</th>
<th>Fuse Ratings Amperes RMS ⓞ</th>
<th>Fault Close</th>
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* Less holder/end fittings
** Includes silencer or snuffer 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

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- **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.

### Switchgear Components

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<tr>
<th>kV Class</th>
<th>kV BIL</th>
<th>Fuse Unit Type</th>
<th>Mounting Catalog Number *</th>
<th>Dimensions in Inches</th>
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</thead>
</table>

* 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.

**Switchgear Components**

- 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.

---

**Table: Dimensions in Inches**

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<th>kV Class</th>
<th>kV BIL</th>
<th>Fuse Unit Type</th>
<th>Mounting Catalog Number *</th>
<th>Dimensions in Inches</th>
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</table>

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

Accommodates FP-3097 End Fittings and S&C SMU-20 Fuse Unit and also accommodates 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

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<th>Max. Cont.</th>
<th>Load-break</th>
<th>Interrupting SYM</th>
<th>Momentary &amp; Three-Time Fault-Close ASYM</th>
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<tr>
<td>S&amp;C SM-4</td>
<td>200</td>
<td>200</td>
<td>12,500</td>
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<td><strong>At 25kV Nominal Voltage • 125kV BIL</strong></td>
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<tr>
<td>S&amp;C SM-4</td>
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<td>200</td>
<td>12,500</td>
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<td>12,500</td>
<td>20,000</td>
<td>540</td>
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</tbody>
</table>

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

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 closed. 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 switch and bus insulators, bushings, and bushing wells are 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

<table>
<thead>
<tr>
<th>Components</th>
<th>Insulators</th>
<th>200A Bushing Wells</th>
<th>600A Bushings</th>
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<td>♦ XM 44-3204</td>
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</table>

#### Design Parameter

| Voltage | Nominal, kV | 15 | 25 | 25 | 35 | 8.3 | 15.2 | 15 | 15 | 25 | 15 | 25 | 25 |
|         | Max Design, kV | 17 | 27 | 27 | 38 | — | — | 17 | 17 | 27 | 17 | 27 | 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 † | 540 † | 540 † | 2,000 | 2,000 | 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 (core) and its internal threads, respectively. The tensile and torsion requirements for the bushing well stud are significantly lower (refer to IEEE Std 386™-2016).
♦ Catalog number applies to bushing well or bushing only. For clamp ring and mounting hardware, add suffix “-01” to catalog number.

### Disclaimer and Limitation of Liability
The information contained in this data sheet is accurate to the best of our knowledge. All data and recommendations are based on tests we believe to be reliable. All products are designed strictly for specific applications. It is the sole responsibility of the buyer to determine the suitability of the products for any other contemplated use. If the products are used for any application other than those specified, Federal Pacific will not be liable for any injury or damage arising from their use.
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.

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