FP AUTOMATIC METAL-ENCLOSED SWITCHGEAR

5kV through 38kV

Four-bay assembly of Federal Pacific Automatic Source-Transfer Switchgear featuring Federal Pacific Automatic-Transfer Micro-Processor Control, switch operators and load-interrupter switches.

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 opq`erating 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

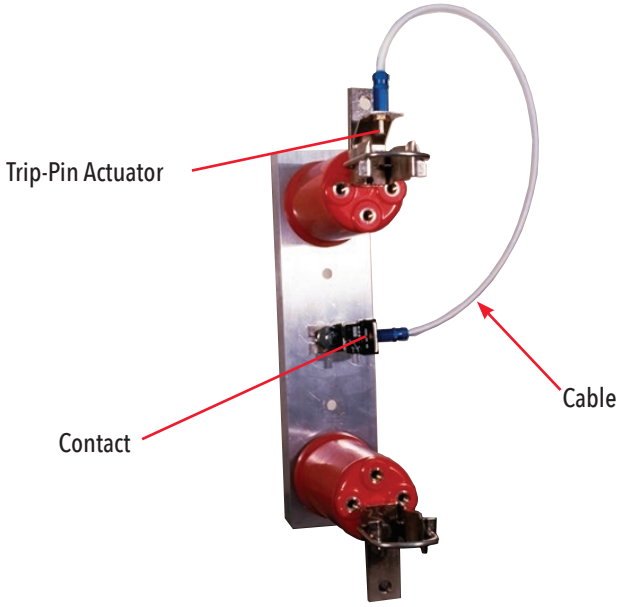

Figure 2

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

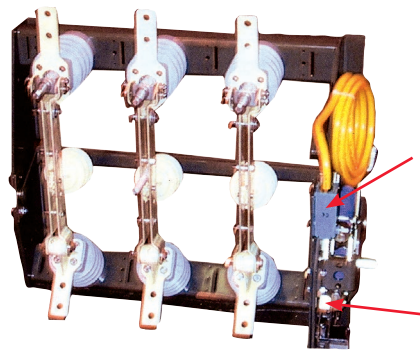

Figure 3

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

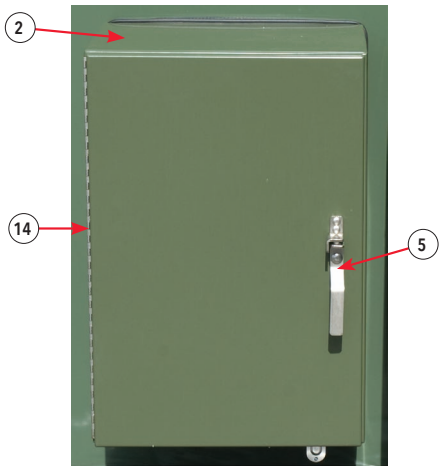

Figure 4. Enclosure of Run-and-Trip motor operator.

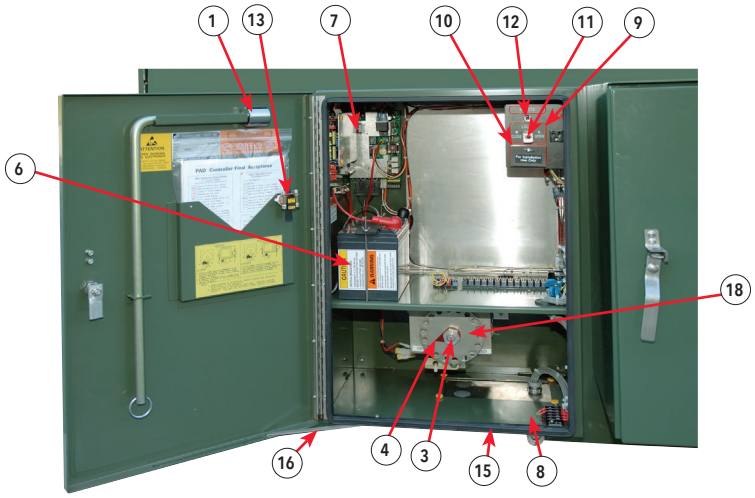

Figure 5. Interior of Run-and-Trip motor operator.

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.

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

Figure 1. View of typical low-voltage control cabinet (above) that includes the automatic-transfer control relay and associated components.

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 Source1 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 3V0)

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.

Figure 2. functional status LEDs and labels.

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

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 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

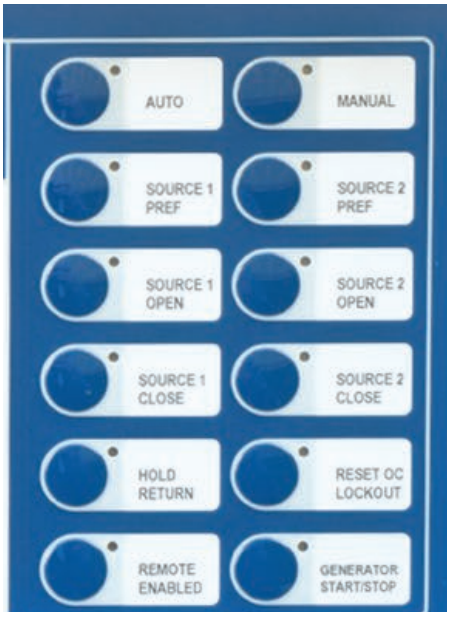

Figure 3. Interactive soft keys include LED lamp and label.

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

Figure 4. SEL-451 LCD display.

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