AUTOMATIC-TRANSFER PAD-MOUNTED SWITCHGEAR
LIVE-FRONT - TYPE ATPSI/II
DEAD-FRONT - TYPE ATPSE
15kV • 25kV

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.

Figure 1. Exterior view of a six-compartment Federal Pacific Automatic-Transfer, Pad-Mounted Switchgear showing the motor operator and control compartment on each side. The control compartment contains the Federal Pacific Automatic-Transfer Software Program in the SEL-451 Relay. The Federal Pacific Switch Operators are in separate compartments. The automatic transfer system provides the customer with two independent power sources to assure service continuity for critical loads. The Federal Pacific Live-Front Automatic-Transfer Pad-Mounted Switchger is configured in a similar manner. For views of switch and fuse compartments for Federal Pacific Live-Front Pad-Mounted Switchgear refer to pages 9 and 11, and for Federal Pacific Dead-Front Pad-Mounted Switchgear refer to pages 31-33.

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.

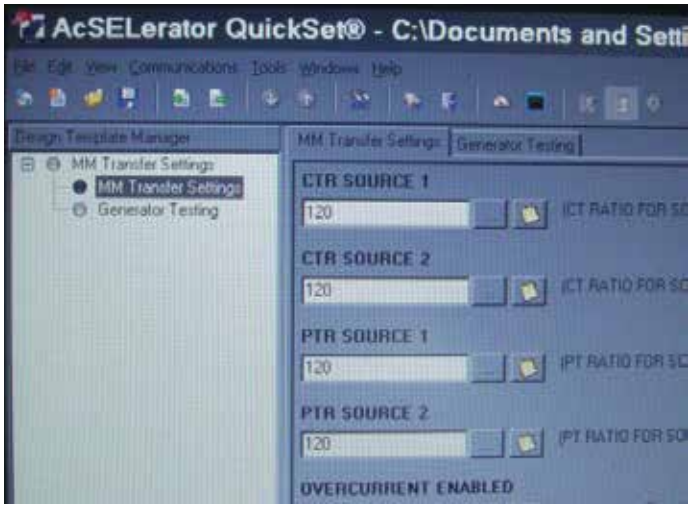

Figure 2. The Field Selectable functions are found in the "MM Transfer Settings" screen within the imbedded software furnished with the pad-mounted switchgear. Two drop-down menus are provided. When the service is from two utility sources the functions are included on the "MM Transfer Settings" When the alternate source is a standby generator, additional field selectable functions are provided and these are found In the "Generator Testing" tab.

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 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 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.

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.

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

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

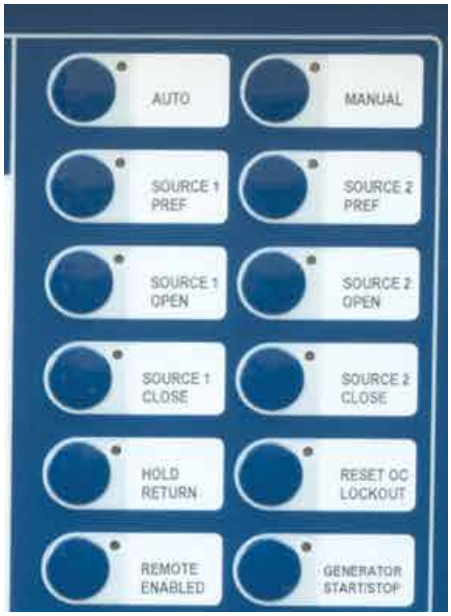

Figure 4. Twelve (12) interactive soft keys provide Local Operation capability on the faceplate of the SEL-451 relay. With Local Operation capabilities, operating personnel can perform switching operations and other key functions with direct interface on the relay.

Figure 5. The LCD screen presents the continuously scrolling primary display points. In addition, soft keys facilitate navigation among the primary display points and the "Main Menu Screen", which provides additional display points for the "EVENTS", editing of the "DATE/TIME" and the keying the "DISPLAY TEST" of all LEDs.

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

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

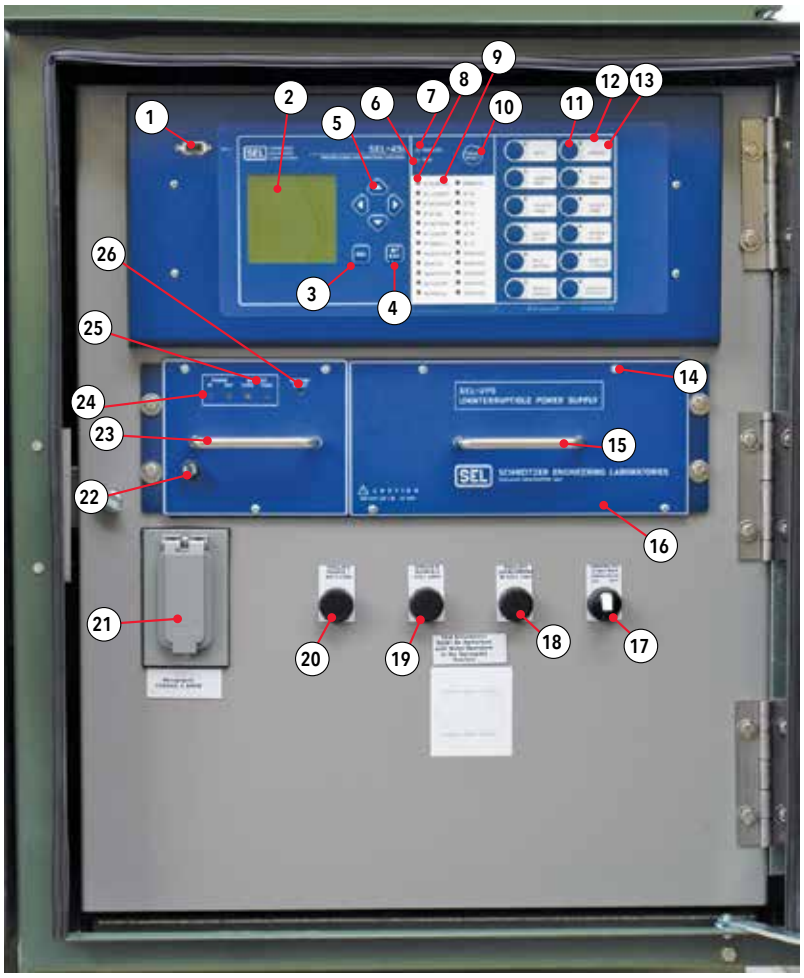

Figure 6. Faceplates and features of the SEL-451 relay and the UPS are illustrated above and each is identified by a numbered callout.

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

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.

STANDARD SPECIFICATION FOR LIVE-FRONT AUTOMATIC-TRANSFER PAD-MOUNTED SWITCHGEAR

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)

System Voltage Class			
		15kV	25kV
kV, Nominal		14.4	25
kV, Maximum Design		17.5	27§
kV, BIL		95	125
Main Bus Continuous, Amps		600	600
Switch Load-Interrupting, Amps		600	600
Switch Fuse Load-Interrupting, Amps		200	200
Switch Short-Circuit Ratings ①②			
Amps, RMS Symmetrical	Standard	14,000	12,500
	HFC	25,000	25,000
MVA, 3-Phase Symmetrical at Rated Nominal Voltage	Standard	350	540
	HFC	620	1,080
Fault-Closing Amps, RMS, Asym., 3-Time Duty-Cycle ③	Standard	14,000	12,500
	HFC	40,000	40,000

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.
§Maximum design of the 27kV switch is 29kV.

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:

Fuse Ratings						
Fuse Manufacturer	Fuse Type	Three-Phase MVA Sym	Amps RMS Asym	3-Time Fault-Close Asym ①	Cont. Amps	Load-Break Amps ①
14.4 kV Nominal Voltage						
S&C	SM-4	310	20000	20000	200	200
S&C	SMU-20	350	22400	22400	200	200
S&C	SM-5‡	–	–	–	–	–
Eaton	DBU	350	22400	22400	200	200
Cooper (M-E)	NX	620	40000	40000	100*	100
Cooper (CT)	X-Limiter	620	40000	40000	140	140
Cooper	CMU	350	22400	22400	200	200
25 kV Nominal Voltage						
S&C	SM-4†	540	20000	20000	200	200
S&C	SMU-20	540	20000	20000	200	200
S&C	SM-5‡	–	–	–	–	–
Eaton	DBU	540	20000	20000	200	200
Cooper (M-E)	NX	1,080	40000	40000	40	40
Cooper (CT)	X-Limiter	1,080	40000	40000	40	40
Cooper	CMU	540	20000	20000	200	200

① When assembled with appropriate end fittings.
** 100 amp @ 13.5 kV max or 80 amp @ 15 kV.*
† 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.

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 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 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 unitized 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 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. 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 located above the door opening. The holder shall be hidden from view when the door is closed; it shall not be possible for the holder to swing inside the enclosure.

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.

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:

c) 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, 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 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 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 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.

Notes

STANDARD SPECIFICATION FOR DEAD-FRONT AUTOMATIC-TRANSFER PAD-MOUNTED SWITCHGEAR

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:

System Voltage Class			
		15kV	25kV
kV, Nominal		14.4	25
kV, Maximum Design		17.5	27§
kV, BIL		95	125
Main Bus Continuous, Amps		600	600
Switch Load-Interrupting, Amps		600	600
Switch Fuse Load-Interrupting, Amps		200	200
Switch Short-Circuit Ratings ① ②			
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 ③	Standard	22,400	20,000
	HFC	40,000	40,000

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.

§Maximum design of the 27kV switch is 29kV.

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.

Fuse Ratings				
Fuse Manufacturer	Fuse Type	Three-Phase MVA Sym.	Amps RMS Asym. ①	Cont. Amps
14.4 kV Nominal Voltage				
S&C	SM-4	310	20000	200
S&C	SMU-20	350	22400	200
S&C	SM-5 ‡	–	–	–
Eaton	DBU	350	22400	200
Cooper	CMU	350	22400	200
Cooper (M-E) ②	NX	620	40000	100*
Cooper (CT) ②	X-Limiter	620	40000	140
Thomas & Betts ②	Hi-Tech	620	40000	140
25 kV Nominal Voltage				
S&C	SM-4 †	540	20000	200
S&C	SMU-20	540	20000	200
S&C	SM-5 ‡	–	–	–
Eaton	DBU	540	20000	200
Cooper	CMU	540	20000	200
Cooper (M-E) ②	NX	1080	40000	40
Cooper (CT) ②	X-Limiter	1080	40000	40
Thomas & Betts ②	Hi-Tech	1080	40000	50

① The fuse mounting can withstand rated fault amperes up to three times and remain operable and able to carry its rated load current. For rating applicable to fault-closing capability of the separable connector (elbow), refer to elbow manufacturer.
② 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.
****** 100 amp @ 13.5 kV max or 80 amp @ 15 kV.*
***†** 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.

o) In consideration of tamper resistance, the enclosure shall conform to or exceed the requirements of IEEE C57.12.28 – Pad-Mounted Equipment Enclosure Integrity.

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 actuating 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 louvered 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 6-8 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 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 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.

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) 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.

Notes