

SECTION 261317 – UNDERGROUND MEDIUM-VOLTAGE FUSIBLE INTERRUPTER SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. This Section specifies the medium voltage switchgear and fusing for buildings and structures.
2. Provide all labor, materials, and equipment as necessary to complete all work as indicated on the drawings, and as specified herein for a complete operating system.
3. Furnish, install, and connect complete for operation new metal clad primary switch unit and make all necessary wiring connections to the primary feeders as required by the drawings and for a complete working job.
4. Medium-voltage switchgear shall include the following items at a minimum:
 - a. Medium voltage interrupter switchgear
 - b. Medium voltage power fuses

B. Related Sections:

1. Applicable sections of Division 26 - Electrical

1.3 SUBMITTALS

A. Shop Drawings

1. Medium-voltage switchgear
2. Medium-voltage fuses

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70, “National Electrical Code”
- C. The switchgear shall conform to the following:
 - 1. ANSI C57.12.28
 - 2. IEEE Standards
 - 3. NEMA Standards
 - 4. National Electrical Code Article 710-21(e)
- D. Guarantee
 - 1. Furnish full parts and labor warranty to cover the switchgear for one year from date of installation.

1.5 MATERIAL TURN OVER TO OWNER

- A. Products Supplied But Not Installed Under This Section
 - 1. Provide one spare set of primary fuses for each fused compartment in this switchgear.
 - 2. Portable control station with 50 ft. cord.
 - 3. Test accessory.
 - 4. Maintenance cable (nine pin).
 - 5. Pentahead socket.
 - 6. Grappler handling tool.
 - 7. Any other miscellaneous components and accessories.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The pad-mounted gear shall be in accordance with the one-line diagram, and shall conform to the following specification.
- B. The pad-mounted gear 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.
- C. The ratings for the integrated switchgear assembly shall be as follows:
 - 1. kV, Nominal 14.4

2.	kV, Maximum Design	17.0
3.	kV, BIL	95
4.	Main Bus Continuous, Amperes	600
5.	Short-Circuit Ratings	
a.	Amperes, RMS Symmetrical	20,000
b.	MVA Three-Phase Symmetrical at Rated Nominal Voltage	500
6.	Duty-Cycle Fault-Closing Amperes, RMS Asymmetrical	32,000

- D. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.
- E. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.
- F. To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.
- G. 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.

2.2 INSULATORS

- A. The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:
 - 1. Operating experience of at least 15 years under similar conditions.
 - 2. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.
 - 3. Adequate strength for short-circuit stress established by test.
 - 4. Conformance with applicable ANSI standards.
 - 5. 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.

2.3 HIGH-VOLTAGE BUS

- A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.
- 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 ½” – 13 galvanized steel bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to 50 foot-pounds torque.
- D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine 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. The bus shall be reinforced and the mini-rupter switch shall be the heavy-duty type providing a higher fault rating.

2.4 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 3/8” thick steel, which shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.
- C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.5 LOW-VOLTAGE COMPONENTS

- A. All low-voltage components, including stored-energy 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 in grounded conduit or raceways where necessary for isolation from high voltage.

2.6 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. A separate grounded, steel-enclosed low-voltage control compartment shall be provided for the source-transfer control and stored-energy operators.
- C. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.
- D. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.
- E. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.
- F. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.
- G. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry. 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.
- H. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which shall allow ventilation of high-voltage compartments to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.
- I. A heavy coat of insulating “no-drip” compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.
- J. Insulating interphase and end barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus.
- K. Full-length steel barriers shall separate side-by-side compartments.
- L. 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. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).
- M. Interrupter switches shall be provided with window panels to allow viewing of the switch position without removing the dual-purpose front barriers. Window panels shall be removable to facilitate phasing and shall be secured to the enclosure with stainless-steel or zinc-nickel-plated hardware.
- N. 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).

- O. The low-voltage control compartment shall be provided with an instruction manual holder.
- P. Lifting tabs shall be removable. 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 closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

Use the following paragraph when additional cable space is required.

- Q. 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.

2.7 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 a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.
- C. Doors providing access to the low-voltage control compartment shall have 90-degree flanges providing a deep overlap with the door openings. To keep low-voltage components clean and dry, these doors shall be fully gasketed.
- D. Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door 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 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 pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
 - 3. The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

- a. It shall not be possible to unlatch the mechanism until the padlock is removed, and,
 - b. It shall not be possible to insert the padlock until the mechanism is completely latched closed.
- F. Doors providing access to power fuses shall have provisions to store spare fuse units or refill units.
- G. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

2.8 VENTILATION OPENINGS

- A. Rain-resistant vents shall be provided on doors providing access to the low-voltage control compartment.
- B. Each vent shall have an inside screen and baffle to protect against insertion of foreign objects.

2.9 FINISH

- A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.
- B. All exterior seams shall be filled and sanded smooth for neat appearance.
- C. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.
- D. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:
 - 1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:
 - a. Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
 - b. Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.

2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714.
 3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
 4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
 5. 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking.
 6. Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.
 7. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.
- E. Certified test abstracts substantiating the above capabilities shall be furnished upon request.
- F. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.
- G. A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.
- H. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.
- I. The finish shall be olive green, Munsell 7GY3.29/1.5.

2.10 MATERIAL

- A. 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-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

2.11 INTERRUPTER SWITCHES

- A. Interrupter switches shall have a two-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 twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum

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

- B. Interrupter switches shall be operated by means of stored-energy operators installed by the switch manufacturer.
- C. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.
- D. Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.
- E. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.
- F. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.
- G. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.
- H. 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.
- I. Key interlocks shall be provided to guard against opening fuse-compartment door(s) unless both interrupter switches are locked open.
- J. Switches shall have provisions to accommodate a variety of cable-terminating devices.

Use the following paragraphs as required by the application.

- K. Base-mounted distribution-class surge arresters, metal-oxide type rated 9 kV shall be provided at all source switch terminals.
- L. Mounting provisions shall be provided to accommodate one three-phase fault indicator with three single-phase sensors in each interrupter switch compartment.

2.12 FUSES

Use the following paragraph for transformer overcurrent protection. Fuse size is from 10A thru 80A.

- A. Switchgear for transformer overcurrent protection shall utilize S&C catalog number 3097 fuse unit end fittings for use with Cooper X Limiter fuses. Fuses shall be Cooper catalog number 83F0xxHC1N (xx = current rating in amperes).

Use the following paragraph for feeder overcurrent protection. Fuse sizes greater than 80 amperes.

Switchgear for feeder overcurrent protection shall utilize S&C catalog number 3142 fuse unit end fittings for use with Cooper X Limiter Full Range fuses. Fuses shall be Cooper catalog number 83Fxxx-I/I with blown fuse indicator (xxx = current rating in amperes).

- B. Provide one spare set of fuses for each fused compartment.
- C. 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. Auxiliary blades or linkages shall not be used.
 - 3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.
 - 4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
 - 5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
 - 6. Circuit interruption shall take place completely within the integral load interrupter with 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 one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 13,000 amperes rms asymmetrical at 14.4 kV. The duty-cycle fault-closing capability defines the level of available fault current into which the fuse can be closed the specified number of times (once or twice), 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.
- D. Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.
- E. 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.

2.13 STORED-ENERGY OPERATORS

- A. Stored-energy operators shall be provided to operate the high-voltage source interrupter switches. They shall be motor charged with solenoid trip-open and solenoid trip-closed operation.
- B. Stored-energy operators shall be equipped with an integral quick-make quick-break mechanism installed by the switch manufacturer, which shall store 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 handle.
- C. Stored-energy operators shall be equipped with tripping solenoids to release the stored energy to open or close the associated source interrupter switch in response to a control signal.
- D. Stored-energy operators shall be equipped with a charging motor that shall charge the quick-make quick-break mechanism after each trip operation when voltage is present on the associated source.
- E. Pushbuttons shall be provided to permit local electrical trip-open and trip-closed operation. Local electrical operation shall be prevented when the source-transfer control is in the automatic mode.
- F. Stored-energy operators shall be provided with an operation selector that shall have the following three positions:
 1. An operating position—when in this position, permits mechanical or electrical opening or closing of the source interrupter switch.
 2. A lock position—when padlocked in this position, prevents all mechanical and electrical operation.

3. A charging position—when in this position, permits manual charging of the quick-make quick-break mechanism while prohibiting mechanical and electrical operation.
- G. Stored-energy operators shall be provided with a charging shaft and a removable manual charging handle to allow manual charging of the quick-make quick-break mechanism in the event control power is lost. The manual charging shaft shall be accessible only when the operation selector is in the “charging” position.
- H. Stored-energy operator shall be equipped with provisions for local mechanical trip-open and trip-closed operation in the event control power is lost.
- I. Stored-energy operators shall be located in a grounded, steel-enclosed low-voltage control compartment. The control compartment shall provide complete isolation from high voltage to help protect operating personnel.
- J. Stored-energy operators shall be equipped with indicators to show whether the quick-make quick-break mechanism is charged or discharged; whether the associated source interrupter switch is in the open or closed position; and whether the stored-energy operator is in the switch-open or switch-closed position.
- K. Each stored-energy operator shall be equipped with an operation counter.
- L. Stored-energy operators shall be provided with a decoupling feature to permit decoupling of the stored-energy operator from the associated source interrupter switch for testing and exercising of the stored-energy operator and source-transfer control without opening or closing the interrupter switch and without exposure to high voltage. A tool shall not be required for decoupling or coupling the switch and switch operator. An indicator shall be provided to show whether the operator is coupled or decoupled. When the stored-energy 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 recouple the stored-energy operator to the source interrupter switch unless the stored-energy operator is in the same position (open or closed) as the source interrupter switch.
- M. Mechanical cable interlocks shall be provided between each stored-energy operator and the associated switch-compartment door to prevent operation of the source interrupter switch when the associated compartment door is open.
- N. Stored-energy operators shall be provided with a key interlocking scheme that will mechanically and electrically block the closing of the switch when the key is removed. The keys will be coordinated with a lock on the fuse compartment door to prevent inadvertent entry into the fuse compartment unless both switches are open.
- O. A receptacle shall be provided for attachment of a remote-control station to allow electrical trip-open and trip-closed operation from an adjacent area.

2.14 SOURCE-TRANSFER CONTROL

- A. Operating Description

1. Transfer on loss and return of source voltage
 - a. The source-transfer control shall utilize the common-bus primary-selective system. The normal condition shall be with one source interrupter switch (for the preferred source, as field programmed) closed to energize the high-voltage bus, and with the other source interrupter switch (for the alternate source) open with its associated circuit available as a standby. The control 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 level) for a period of time 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.
 - b. When normal voltage returns to the preferred source for a preset time, the control shall initiate retransfer to the preferred source if in the automatic return mode, or await manual retransfer if in the hold return mode. In the hold return mode, if the alternate source fails and the preferred source has been restored, the control shall initiate automatic retransfer to the preferred source.
 - c. In the automatic return mode, the control shall provide either open transition (non-paralleling) or closed transition (paralleling) on retransfer, as field programmed.
2. Transfer on unbalance condition
 - a. A field programmable unbalance detection feature 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 shall continuously develop and monitor the negative-sequence voltage to detect any unbalance present as a result of an open-phase condition. Automatic switching shall occur when the system unbalance exceeds a predetermined unbalance-detect voltage for a period of time sufficient to confirm that the condition is not transient.
 - b. When normal phase voltages return to the preferred source, the control shall initiate retransfer to the preferred source as described above.

B. Control Features

1. The operating characteristics of the source-transfer control and its voltage-, current-, and time-related operating parameters shall be field programmable and entered into the control by means of a keypad. To simplify entry of this information, a menu arrangement shall be utilized including keys dedicated to the operating characteristics and to each of the operating parameters. Entry of an access code shall be necessary before any operating characteristic or operating parameter can be changed.
2. All operating characteristics and operating parameters shall be available for review on a liquid-crystal display with backlighting.

3. Light-emitting diode lamps shall be furnished for indicating the presence of acceptable voltage on each high-voltage source.
4. A light-emitting diode lamp shall be furnished for indicating that both stored-energy operators are coupled to their respective interrupter switches and in the correct positions, the control is in the automatic mode, the operation selector for each stored-energy operator is in the operating position, and all control circuitry is properly connected for automatic transfer. The display specified above, when not being used to show menu information, shall show messages explaining why this lamp is not lighted.
5. A selector switch shall be furnished for choosing manual or automatic operating mode. 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. Test keys shall be furnished for simulating loss of voltage on each of the two sources, as well as for checking the functioning of the lamps, display, and keypad.
7. The control shall include built-in diagnostics for analyzing system events. The device shall automatically record system status and source-transfer control status every time a control operation occurs. All such operations shall be indicated by the illumination of a light-emitting diode lamp and shall be available for display by means of a dedicated event key.
8. The present source voltage and current inputs, and the present status of discrete inputs to and outputs from the control shall be available for display by means of a dedicated examine key.
9. The control shall have the capability to automatically calibrate to a known voltage on each source. This capability shall be keypad selectable.

C. Construction Features

1. The source-transfer control shall use an advanced microprocessor and other solid-state electronic components to provide the superior reliability for use in power equipment. All components shall be soldered on printed circuit boards to minimize the number of interconnections for increased reliability.
2. All interconnecting-cable connector pins and receptacle contacts shall be gold-over-nickel plated to minimize contact pressure.
3. The surge withstand capability of the control shall be verified by subjecting the device to both the ANSI Surge Withstand Capability Test (ANSI Standard C37.90.1) and to a 5 kV, 3.75 joule capacitive-discharge test. For the capacitive-discharge test, a suitable capacitor shall be charged to 5 kV, and shall then be used to discharge 3.75 joules into each input circuit and each output circuit of the device.
4. To identify and eliminate components that might be prone to early failure, the control shall be subjected to a dielectric test, a functional check, and a 72-hour screening test followed by a second functional check. For the screening test, the device shall be

energized at rated control voltage while subjected to a maximum-design operating temperature of +70°C for 24 hours, followed by 48 hours during which the temperature is cycled repeatedly between -40°C and +70°C.

5. The control shall be located in the grounded, steel-enclosed low-voltage compartment with the stored-energy operators. The control compartment shall provide isolation from high voltage.
- D. Voltage Sensing and Control Power
1. Voltage sensing and control power shall be provided by three capacitively coupled voltage sensors on the line side of each source interrupter switch.
 2. To maximize usable cable-training space within the pad-mounted gear, the voltage sensors shall directly replace the lower apparatus insulators of the source interrupter switches. Furthermore, the voltage sensors shall be constant-current-output devices that do not require primary fuses.
 3. The output of the voltage sensors shall be directly proportional to line-to-ground voltage and shall have relay accuracy over an ambient temperature range of -40°F to +160°F.
 4. Each voltage sensor shall be equipped with a secondary-side protective device to prevent damage to the voltage sensor in the event that the secondary circuit is inadvertently opened or the burden is removed.
- E. An overcurrent-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 diode 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. Provisions shall be furnished for manually resetting the overcurrent-lockout feature from a remote location. Test keys shall be provided for simulating an overcurrent condition on each source.
- F. Remote-indication provisions shall be provided to permit remote monitoring of the presence or absence of preferred- and alternate-source voltage; the operating mode of the source-transfer control (i.e., automatic or manual); and the status of the stored energy operator indicating lamp, the source transfer control indicating lamp, and overcurrent lockout.
- G. A test panel shall be provided to permit the use of an external, adjustable three-phase source to verify, through independent measurement, the response of the control to loss-of-source, phase-unbalance, and (where applicable) overcurrent-lockout conditions.
- H. Supervisory control provisions shall be provided to permit switch operation from a remote location.
- I. A communications card shall be provided to permit local loading, to a user-furnished personal computer, of system events recorded by the source-transfer control; operating characteristics and voltage-, current-, and time-related operating parameters programmed in the control; discrete inputs and outputs from the control; and messages explaining why the stored energy operator indicating lamp is not lighted. The communications card shall also permit local

downloading of the user's standard operating parameters from the personal computer to the control

2.15 LABELING

A. Hazard-Alerting Signs

1. All external doors providing access to high voltage shall be provided with "Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.
2. The inside of each door providing access to high voltage shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
3. Interrupter switch compartments shall be provided with "Danger" signs indicating that "Switches May Be Energized by Backfeed".
4. Fuse compartments shall be provided with "Danger" signs indicating that "Fuses May Be Energized by Backfeed".
5. Barriers used to prevent access to energized live parts shall be provided with "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" signs

B. Nameplates, Ratings Labels, and Connection Diagrams

1. The outside of each set of double doors providing access to high voltage shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.
2. The inside of each set of double doors shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and MVA three-phase symmetrical at rated nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).
3. The inside of each set of double doors shall be provided with a three-line connection diagram showing interrupter switches, fuses with integral load interrupter, voltage sensors, and bus along with the manufacturer's model number.

2.16 ACCESSORIES

- A. End fittings or holders, and fuse units, refill units, as well as one spare set of fuse units and refill units for each fused compartment.

- B. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

PART 3 - EXECUTION

3.1 PRIMARY CONNECTIONS

- A. Primary connections between primary selector switches, transformer load break switches, and transformers shall be cable, as shown on the drawing.
- B. Primary cable shall be three, minimum size no. 2 AWG, 1/C, 15KV, shielded cable. Cable construction shall be uncoated soft or annealed copper, strand shield, ethylene propylene rubber insulation (133% insulation level), semiconducting insulation shield with 26-#14 copper wires wound over shield, and 80 mil polyethylene jacket. Cable shall be manufactured by Kerite, Okonite, BICC, or Pirelli.
- C. Terminations shall be made by a cable splicer or qualified journeyman using packaged Class 1 Outdoor termination kits. Terminations shall be Raychem HVT-150-SJ series or 3M 7640-T series.
- D. Phasing shall be marked at each termination location of 15KV cable in switchgear using 1 inch high, white, adhesive labels. Marking to be X, Y, Z reading left to right, or front to back while facing front of switchgear.

END OF SECTION 261317