



35-kV Safefront Primary Capacitor Station Pad-Mounted Outdoor

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General

The primary capacitor station shall be 35-kV class, 150 kV BIL, 200-ampere continuous current, suitable for use on 21.1/36.5-kV grounded wye max design systems. The primary capacitor station shall be constructed for connection to the utility system with loadbreak separable insulated connectors as described in IEEE Standard 386—latest revision (separable insulated connectors and loadbreak inserts shall be supplied by the user). The capacitor station shall be designed for and contain (or accept) fuses, switches, control power transformer and standard outdoor single-phase capacitors in a compartment separated from the elbow compartment by a steel equipment plate. Separate access shall be provided for each compartment. A door safety barrier shall be provided inside the door(s) on the capacitor compartment as recommended in IEEE Standard C2 (National Electrical Safety Code) Rule 381G. Tamper resistance shall meet the Enclosure Security requirements of IEEE Standard C57.12.28 (Pad-Mounted Equipment—Enclosure Integrity). Together, the tamper resistance and the door safety barrier shall resist unauthorized entry, protect authorized and unauthorized persons, and provide positive safety features when installed in areas accessible to the general public. The primary capacitor station shall be constructed for outdoor installation in areas subject to heavy precipitation and in areas with windblown contamination. The equipment shall be “air-insulated” and completely assembled prior to shipment.

Enclosure Construction

The enclosure shall be tamper-resistant, all-welded construction utilizing 11-gauge minimum sheet steel. Corner plates and braces shall be used as necessary to assure rigidity. The enclosure top shall be cross-kinked to provide watershed and rigidity. The enclosure shall be open bottom with a 1-inch flange inside, all around. Separate compartments shall be provided for cable termination and for capacitor equipment—each compartment equipped with its own individual access door(s) furnished with a stainless-steel door holder that will latch the door open 100 degrees and 140 degrees and resist accidental closing. The equipment plate separating the two compartments shall be full length, constructed with 11-gauge minimum sheet steel braced to assure rigidity when operating the elbows. Doors shall be provided with provisions for padlocking and a recessed penta-head (or hex-head) security bolt to prevent unauthorized entry (coordinated to prevent installation of the padlock until the security bolt is tightened *when closing the door(s)* and to prevent a wrench from operating the security bolt until the padlock is removed *when opening the door(s)*). The security bolt shall be made captive with a stainless-steel washer compressed to an oval shape to severely discourage removal. Hinges shall be stainless steel

(with stainless-steel pins not less than 0.3125-inch diameter) and shall be welded to both the enclosure and the door(s) to maintain door alignment for the life of the equipment. The control power transformer mounting plate shall be constructed with 11-gauge minimum sheet steel formed and reinforced to provide proper support for the transformer installed (or to be installed) thereon. The mounting plate shall be punched with a pattern of holes that accept installation of all NEMA standard outdoor instrument transformers without the need to punch or drill additional holes. The pattern of holes shall be located to place the transformer in a position that provides proper electrical clearance. A 0.375-inch diameter cable-lacing rod shall be welded to the front edge of the transformer mounting plate and on both inside walls of the capacitor compartment (with stand-off clearance of 0.75 inch) to provide support for secondary wiring. Ventilation, which meets the tamper resistance requirements of IEEE Standard C57.12.28, shall be provided in the top and bottom sill of the elbow compartment side of the enclosure and in the top and bottom sill of the capacitor equipment compartment side of the enclosure. Open-pore filter foam shall be installed in the outermost ventilation area to prevent entry of wildlife including wasps and similar size insects. The protective finish shall include necessary grinding, 5-stage cleaning and phosphatizing, two-component rust-inhibiting zinc rich epoxy primer and a pad-mount green two-component polyurethane top coat finish (Munsell color 7GY 3.29/1.5). The primer and top coat shall be electronically monitored during application to insure proper ratio and mixing of each component. Total average thickness of paint (after curing) shall be not less than 5 mils. The protective coating shall meet the Enclosure Coating System requirements of IEEE Standard C57.12.28 (Pad-Mounted Equipment—Enclosure Integrity). Removable lift provisions, adequate to withstand handling with normal utility equipment, shall be provided on the outside of the enclosure. Threaded openings for lift provision bolts shall be blind holes to prevent the entrance of wire or other foreign objects into the enclosure when lift provisions are removed.

Bushings and Terminals

Bushings shall be 200-ampere Elliott #1102-235B, 35-kV class (21.1 kV to ground) Air-Insulated Bushing Wells, 150 kV BIL, per IEEE Standard 386 Fig. 3 (200 A Bushing Well Interface, 8.3 kV, 15.2 kV and 21.1 kV) *for use with 21.1/36.6-kV separable insulated connectors* (Elastimold® or other approved equal). The bushing wells shall be pressure-molded cycloaliphatic epoxy with a 0.75-inch diameter copper conductor on the “air-insulated” side that is drilled and tapped 0.375-inch – 16UNC x 1-inch deep to provide direct connection of the bus and/or live parts. Leakage distance from the apparatus connection end of the bushing well to ground shall



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be not less than 40 inches to assure trouble-free operation in a wet and/or contaminated environment. Integral shielding shall be provided to eliminate partial discharge caused by off-center mounting and mounting holes that may have sharp edges or burrs. Bushing wells shall mount in a 3.125-inch diameter opening and bolt in place to allow field replacement with standard tools. The bushing mounting bolts shall be self-locking stainless steel serrated-flange hex-head bolts that cut through the enclosure protective finish to ground the integral shielding of each bushing. The head of one or more of the mounting bolts for each bushing shall include a 0.156-inch diameter hole to provide a connection to ground for the loadbreak insert shielding ground wire as recommended by separable insulated connector manufacturers. To assure adequate strength for apparatus support, the bushing well shall withstand a minimum cantilever loading of 600 pounds for five minutes without damage. The bushing well interface shall be free of all voids, holes and heat sinks to assure proper mating with separable insulated connectors. Each bushing well shall be tested in free air, mounted in a grounded steel plate not less than 10 inches x 10 inches, and with a bushing well plug (RTE #IBWP225 or equal) installed in the well interface to accurately simulate operating conditions (*gas or liquid dielectric in the interface shall not be acceptable for this test*). Each bushing shall meet the requirements for 35-kV devices in accordance with the test values of IEEE Standard 386 (latest revision), including 100 percent production testing.

Bus and Fuse Mountings

Bus shall be copper with all burrs and sharp corners removed prior to installation. Fuse clips and/or fuse hinges shall be keyed to prevent rotation and to maintain alignment. Positive pressure shall be assured by use of stainless steel fasteners and lock washers or compression washers at all connection points. All connections shall provide direct contact of current-carrying parts and shall not depend on current transfer through fastener thread-to-thread contact. Fuses and their blown-fuse indicators shall be visible (*when the capacitor compartment door(s) are open*) without removal of the clear-polycarbonate door safety barrier to allow easy identification of blown fuses without de-energizing or removing the fuse from service. Electrical components shall be "air-insulated" and positioned to allow visual inspection of all internal connections and components *without removing the clear-polycarbonate door safety barrier*, de-energizing or removing the equipment from service.

Alternate 1: Group Fuses Only

Fuse mountings shall be Mounting Code 6 to accept 1.5-amp to 40-amp (max), 23-kV Cooper Power Systems (McGraw-Edison) NX[®] and 6-amp to 40-amp (max), 23-kV Cooper Power Systems X-Limiter[™] clip-mounted current-

limiting fuses. A Danger Sign, Elliott #7203-D2003-313, shall be provided in a prominent location near the fuse clips to warn the operator "Do not remove fuse under load."

Alternate 2: Individual Fuses Only

Each capacitor shall be fused with a 6-amp to 40-amp (max), 23-kV Cooper Power Systems bolted-tab X-Limiter[™] limiting fuse. A Danger Sign, Elliott #7203-D2003-313, shall be provided in a prominent location near the fuses to warn the operator "Do not remove fuse under load."

Alternate 3: Group and Individual Fuses

Fuse mountings for group fuses shall be Mounting Code 6 to accept 1.5-amp to 40-amp (max), 23-kV Cooper Power Systems (McGraw-Edison) NX[®] and 6-amp to 40-amp (max), 23-kV Cooper Power Systems X-Limiter[™] clip-mounted current-limiting fuses. In addition each capacitor shall be fused with a 6-amp to 40-amp (max), 23-kV Cooper Power Systems bolted-tab X-Limiter[™] current-limiting fuse. A Danger Sign, Elliott #7203-D2003-313, shall be provided in a prominent location near the fuse clips of the group fuses and near the individual fuses to warn the operator "Do not remove fuse under load."

Capacitors

NEMA standard outdoor single-phase, 60-hertz, 150-kV BIL individual capacitors shall be supplied bolted in place and positioned in a manner that will allow replacement without removal of other major components if maintenance is required. The capacitors shall be constructed with "all-film" insulation impregnated with non-PCB liquid dielectric and include one insulated primary bushing (alternate—two insulated primary bushings). The capacitors shall be rated 100 kVAR, 150 kVAR, 200 kVAR, 300 kVAR or 400 kVAR at 19,920 volts and shall be connected grounded wye for operation on a 19.9/34.5-kV grounded wye system.

Oil or Vacuum Switches

Alternate 1: The oil switches shall be standard outdoor single-phase General Electric Type FKC-2 (rated 19.9/34.5 kV and 125-kV BIL) capable of switching solidly-grounded three-phase capacitor banks up to 2,700 kVAR on 19.9/34.5-kV multigrounded-wye systems. The switch shall be motor-operated with 120 volts AC. The 5-pin receptacle shall accept a 5-pin plug (#9F90AAW027) installed on a three-conductor cable, factory connected to the open, close and neutral terminals of a four-terminal meter socket (suitable for field installation of a socket-mounted capacitor control). The three oil switches shall be mounted and positioned so the manual operating handle is visible without entering the enclosure and is accessible for hook-stick operation in the event the switches fail to operate electrically. To facilitate maintenance, the switches shall be located so they can be removed and replaced without disturbing other components in the capacitor compartment.

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Alternate 2: The oil switches shall be standard outdoor single-phase Cooper Power Systems (McGraw-Edison®) Type NRV (rated 20 kV and 125-kV BIL) capable of switching solidly-grounded three-phase capacitor banks up to 2,700 kVAR on 19.9/34.5-kV multigrounded-wye systems. The switch shall be motor-operated with 120 volts AC. The 5-pin receptacle (#KA121 NRS) shall accept a 5-pin plug (#KA48NR) installed on a three-conductor cable, factory connected to the open, close and neutral terminals of a four-terminal meter socket (suitable for field installation of a socket-mounted capacitor control). The three oil switches shall be mounted and positioned so the manual operating handle is visible without entering the enclosure and is accessible for hook-stick operation in the event the switches fail to operate electrically. To facilitate maintenance, the switches shall be located so they can be removed and replaced without disturbing other components in the capacitor compartment.

Alternate 3: The vacuum switches shall be standard outdoor single-phase Trinetics UltraVac Type Ultra 20 (rated 24 kV phase-to-ground and 125/150 kV BIL) capable of switching solidly-grounded three-phase capacitor banks up to 2,700 kVAR on 19.9/34.5-kV multigrounded-wye systems. The switch shall be motor-operated with 120 volts AC. The 5-pin receptacle shall accept a 5-pin plug (#6714) installed on a three-conductor cable, factory connected to the open, close and neutral terminals of a four-terminal meter socket (suitable for field installation of a socket-mounted capacitor control). The three vacuum switches shall be mounted and positioned so the manual operating handle is visible without entering the enclosure and is accessible for hook-stick operation in the event the switches fail to operate electrically. To facilitate maintenance, the switches shall be located so they can be removed and replaced without disturbing other components in the capacitor compartment.

Control Power Transformer

Alternate 1: The control power transformer shall be 35-kV class to provide 120 volts and 600 VA to operate the oil or vacuum switches and capacitor control. The primary of the transformer shall connect to the C-phase bus with #2 stranded copper THWN. The secondary of the transformer shall be factory connected to the hot and neutral terminals of the four-jaw meter socket (or when specified, to the hot and neutral terminals in the junction box).

Alternate 2: The control power transformer shall be 35-kV class to provide 120 volts and 1,000 VA to operate the oil or vacuum switches and capacitor control. The primary of the transformer shall connect to the C-phase bus with #2 stranded copper THWN. The secondary of the transformer shall be factory connected to the hot and neutral terminals of the four-jaw meter socket (or when specified, to the hot and

neutral terminals in the junction box).

Meter Socket for Capacitor Control

Alternate 1: When specified, the meter socket shall be four terminal, 100 amp, with two 1-inch hubs. The socket shall be wired complete and factory-mounted on the exterior of the enclosure. An MR-1 screw-type sealing ring shall be furnished with the socket.

Alternate 2: When specified, the meter socket shall be four terminal, 100 amp, wired complete and mounted on the equipment plate above the elbows. To enable the operator to access the control without opening the elbow compartment door(s), a capacitor control access door shall be provided (furnished with a stainless steel door holder that will latch the door open 100 degrees and 140 degrees and resist accidental closing). The access door shall be provided with provision for a padlock and a recessed penta-head (or hex-head) security bolt to prevent unauthorized entry. The security bolt shall be made captive with a stainless steel washer compressed to an oval shape to severely discourage removal. Hinges shall be stainless steel (with stainless steel pins not less than 0.3125-inch diameter) and shall be welded to both the enclosure and the access door to maintain door alignment for the life of the equipment. Tamper resistance shall meet or exceed the requirements of ANSI Standard C57.12.28 (Pad-Mounted Equipment—Enclosure Integrity). To prevent inadvertent access to the elbows and cables through the capacitor control access door, a clear-polycarbonate (Lexan or equal) safety barrier shall be provided to separate the control section from the elbow section of this compartment. This safety barrier shall be removable (without the use of tools) only when the main elbow compartment doors are open.

Alternate 3: When specified, a junction box shall be supplied in place of the meter socket described in Alternate 1 and Alternate 2. The junction box shall be located as specified by the user.

Surge Arrestors

Alternate 1: Mounting provisions for distribution-class metal-oxide-varistor surge arresters shall be provided in the capacitor compartment, located so the arresters can be installed and replaced without disturbing other components in the capacitor compartment.

Alternate 2: Three 27-kV heavy-duty distribution-class metal-oxide-varistor surge arresters, with silicone-rubber housings and ground-lead isolators, shall be provided in the capacitor compartment, located so the arresters can be replaced without disturbing other components in the capacitor compartment. One arrester terminal shall be connected to the source bushing. The ground-lead isolator shall be connected in a manner that will guide the isolator clear of other components



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in the event of an isolator operation.

Barriers

Phase and ground barriers shall be provided to assure correct phase-to-phase and phase-to-ground clearances for proper operation at rated voltage. These barriers shall be glass-reinforced polyester (NEMA GPO-3 class material) not less than 0.1875-inch thick.

For each phase, a removable insulating barrier with a "DANGER – Keep Out! – Hazardous voltage" sign, Elliott #7203-D2003-309, shall be located inside the door(s) on the capacitor compartment as recommended in Rule 381G of IEEE Standard C2 (National Electrical Safety Code). These *sectional door safety barriers* shall be constructed of 0.25-inch clear polycarbonate (Lexan or equal) and shall *completely close the opening* to each phase. Each barrier shall be provided with a nonconductive safety latch requiring a positive action to remove the barrier. Handles and other hardware extending through the door safety barriers shall be nonconductive material. Handles shall be keyed to prevent rotation for secure handling. *Complete visual inspection of the internal components shall be possible without removing the door safety barrier.*

Grounding Provisions

Four high-conductivity bronze eyebolt-type ground lugs, which accept #6 through #2/0 copper conductor, shall be installed—two in the cable terminating compartment and two in the primary capacitor compartment—on each side of the door opening in an accessible position (as shown on the drawings).

Accessory Equipment

Stainless steel parking stands shall be provided in the quantity required to allow use of feed-thru bushings, parking bushings and grounding bushings. The parking stands shall be welded in place, in a position to allow the use of hot-line tools for installation of feed thru-bushings, etc. The parking stands shall be *unpainted* (except welds shall be painted) *to provide a ground* for feed-thru bushings and other devices that may be placed into the parking stands. *Keyed retainers* shall be welded above each parking stand *to prevent slipping or accidental removal* of portable devices such as feed-thru bushings, etc.

An anodized aluminum nameplate shall be installed inside one door on the elbow compartment. It shall be located at the top corner farthest from the elbows when the door is open. The nameplate will provide Type of Equipment, Model Number, Amps Continuous, kV Maximum, BIL, Serial Number, Date Manufactured and Weight of Equipment.

Bus and primary capacitor connections between bushings

shall be displayed (on the cable side of the equipment plate) using 0.5-inch-wide solid orange-color pressure-sensitive vinyl tape. Switches, fuses and capacitors shall be indicated with vinyl labels using letters not less than 0.375-inch nor more than 0.625-inch high. The resulting schematic shall clearly indicate the circuit arrangement of the capacitor station. The schematic shall be legible at a distance of six feet or more.

Alternate 1: A Warning Sign, Elliott #7201-W2003-323, shall be provided in two prominent locations (on the cable side of the equipment plate) near the bushing wells to warn the operator "Do not operate elbows unless Oil Switches are open."

Alternate 2: A Warning Sign, Elliott #7201-W2003-324, shall be provided in two prominent locations (on the cable side of the equipment plate) near the bushing wells to warn the operator "Do not operate elbows unless Vacuum Switches are open."

When enclosures have more than one door (or other access provision) each access shall be labeled in near proximity of the locking provisions with a pressure-sensitive vinyl label using letters not less than 0.375-inch nor more than 0.625-inch high. The label shall indicate the type of equipment behind the access (elbows, capacitors, etc.).

When specified, four anchor-bolt brackets, Elliott #6102-A81-7 or approved equal, shall be supplied with each capacitor station to provide a means of clamping the equipment to the concrete pad.

Packaging

Each capacitor station shall be bolted to a solid-top wood pallet (to prevent the forks of a forklift truck from entering the open bottom of the equipment) to prevent hidden damage. The equipment shall be wrapped with 0.125-inch thick polyethylene foam or other suitable material to minimize damage to the finish during shipment.

Drawings

When specified, drawings shall be furnished for each capacitor station that include:

- 1) enclosure dimensions and location of components.
- 2) proposed cable-training layout and dimensions.
- 3) proposed pad dimensions and location of anchor bolts.