SPECIFIC INSTRUCTIONS

SP2020 - Southside Capacitor Bank 6C2 Replacement

Abstract

This document covers general and site specific instructions for successful completion of the project.

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I. GENERAL INFORMATION

This section covers general information of the project including location of site, schedule milestones, contact information, and scope of work.

1. Scope of Work

Remove and dispose the existing 6C2 capacitor bank. Assemble and install a new capacitor bank at the same physical location.

2. Location(s) of Project

Southside Substation is located at: 801 Broadcast Place, Jacksonville, FL 32207.

3. Contact Information

Role	Name	Email	Office #	Cell Phone #
Project Manager	Ryan Szoke	szokrm@jea.com	904-665-4098	904-383-8243
Substation Engineer	Ryan Szoke	szokrm@jea.com	904-665-4098	904-383-8243
Project Representative	Kory Blue	blueks@jea.com		904-719-3010

4. Important Dates and Milestones

Description	Date
Capacitor Bank delivery to site	9/21/2020
Dis-Tran Furnished material delivery to site	9/21/2020
Outage Start	9/22/2020
Contractor Substantially Complete	10/7/2020
Estimated In-Service Date	10/21/2020

5. Documents Provided by Owner

All Technical Specifications and Drawings that have been provided to the Bidder to allow the Bidder to estimate the Bid for the type, kind, and quantity of work to be performed, as well as the type, qualities, and quantities of materials that must be furnished as a part of this Bid, and are provided solely for Bidding purposes. These Technical Specifications and Drawings may not be intended to be used for Construction. Technical Specifications and Drawings for Construction shall be provided not later than the pre-construction conference, at which time if the Contractor can show, in an explicit, formulary way, any direct cost differences between the requirements of the Construction set and the Bid set, JEA will entertain a change order only for that (those) difference(s).

The Owner shall furnish the Contractor no more than two (2) complete hard-copy sets of Construction Drawings and other associated documents for completion of the work.

II. SITE-SPECIFIC INSTRUCTIONS

1. Substation Access

The Contractor shall maintain access to the construction site at all times. The Contractor shall not impede or block the normal operation of neighboring properties, traffic flow, or access to critical substation infrastructure.

2. Laydown Area

The Contractor shall propose and JEA shall approve any area located within the substation fence that shall function as a material laydown area. The laydown area shall be maintained and returned to the original condition by the Contractor immediately after use. The Contractor shall install and maintain temporary fences and gates to secure the designated area. NOTE: A suitably constructed and maintained temporary construction fence, when such fence encompasses a closed perimeter, shall be sufficient for the purposes of this Paragraph.

3. Disposal of JEA Equipment

The Contractor shall NOT be responsible for disposal of oil for any JEA equipment. Instead, the Contractor shall transport such oil-filled equipment to JEA Westside Service Center or as directed by the JEA Project Manager or Representative. Substation O&M shall verify and mark PCB-free equipment before Contractor handling. Suspected or known PCB items shall be handled by and disposed by JEA according to JEA Policy and Procedures: **HANDLING AND DISPOSAL OF POLYCHLORINATED BIPHENYL COMPOUNDS**.

JEA typically retains ownership of scrap metal from JEA assets. If so, JEA will provide container bins on-site for the Contractor to dispose all scrap metal. All other debris shall be properly removed from the site by the Contractor.

4. Sanitary Facilities

The Contractor shall provide and maintain their own sanitary facilities for contractor, sub-contractor, and JEA personnel for use during Construction.

5. Noise & Dust Control

The Contractor is required to minimize noise from pumps and other sources and to maintain dust control throughout Construction.

6. Sequence of Work

The following is a general representation of a possible Sequence of Work, provided only as an example of one such possible sequence. The Contractor shall be responsible for all work coordination, timing, sequencing, and scheduling that is necessary to assure timely project completion even while working with material suppliers and prevailing circumstances (labor, weather, etc.) that could be expected for this locale and time of year.

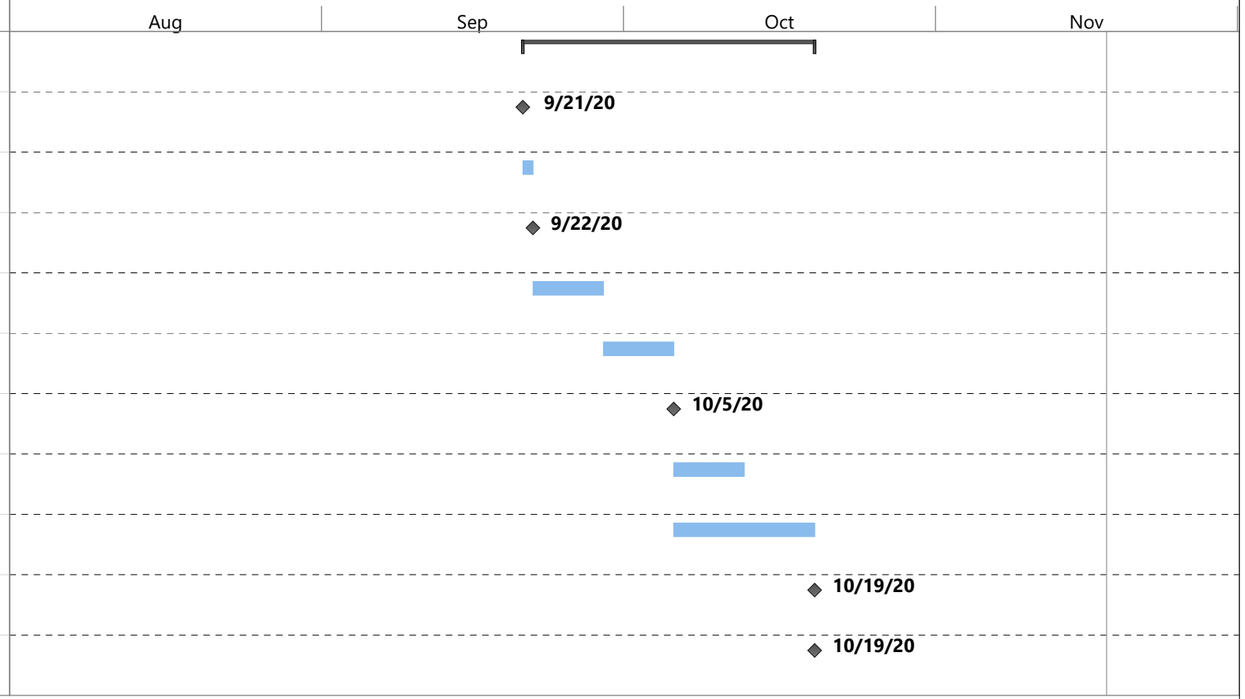
- Contractor Mobilization
- Contractor offload and laydown new capacitor bank and materials delivered to site.
- Commence outage for equipment and work area by JEA.
- Substation O&M verify capacitors and potential transformer are PCB-free.
- Contractor begin removal of existing capacitor bank 6C2 equipment and dispose/transport accordingly.
- Contractor assemble and install new capacitor bank including, grounding, jumpers, conduits, and cables per construction drawings.
- Inspection, site cleanup, punch-list items, and de-mobilization.
- JEA finish final tasks and place equipment back in-service.
- Contractor finalize and deliver As-Builts.

JEA Transmission & Substation Projects - 20410
SouthsideGIS 6C2 Replacement

Status Date: Wed 6/24/20
Filter: Construction

Manager: Darrell Hamilton
Scheduler: Ryan Szoke

ID	WBS	Task Name	Duration	Start	Finish	Predecessors
13	**3**	**Construction**	**21 days**	**Mon 9/21/20**	**Mon 10/19/20**	
14	*3.1*	*Construction Start*	*0 days*	*Mon 9/21/20*	*Mon 9/21/20*	*10FS+5 days*
15	3.2	Receive Subpackager Materials	1 day	Mon 9/21/20	Mon 9/21/20	14
16	*3.3*	*Outage Start*	*0 days*	*Tue 9/22/20*	*Tue 9/22/20*	*14*
17	3.4	Remove Cap Bank 6C2	1 wk	Tue 9/22/20	Mon 9/28/20	16
18	3.5	Install New Cap Bank 6C2	1 wk	Tue 9/29/20	Mon 10/5/20	17
19	*3.6*	*Contractor Substantially Complete*	*0 days*	*Mon 10/5/20*	*Mon 10/5/20*	*18*
20	3.7	PunchList Items	5 days	Tue 10/6/20	Mon 10/12/20	18
21	3.8	Final Wiring & Testing CapBank 6C2	2 wks	Tue 10/6/20	Mon 10/19/20	18
22	*3.9*	*Outage Finish*	*0 days*	*Mon 10/19/20*	*Mon 10/19/20*	*21*
23	*3.10*	*In-Service Date*	*0 days*	*Mon 10/19/20*	*Mon 10/19/20*	*21*



SECTION III - TECHNICAL SPECIFICATIONS - ELECTRICAL

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SECTION III - TECHNICAL SPECIFICATIONS - ELECTRICAL

1. SWITCHYARD ELECTRICAL EQUIPMENT

GENERAL

This is a general specification and covers the equipment required for substation construction. Separate Sections of these Specifications provide further information for High Voltage Transmission Systems, Distribution-class Duct Bank Systems, and Metal-Clad Switchgear, where applicable. Any equipment listed which does not apply to this particular project shall be disregarded. The Drawings shall be used to determine the exact quantity and type of equipment intended for use on this project. In case of discrepancy, the Drawings shall be taken in all cases.

1.1. SCOPE

This Section covers labor, equipment, and material requirements for the installation of the switchyard electrical equipment. The Contractor shall erect in place, test, and leave ready for service, the facilities shown on the Drawings and herein specified. The Contractor shall also have responsibilities for receiving, off-loading, and transporting certain structures, equipment, and miscellaneous materials as called for in this Specification. The Contractor shall furnish and install materials and equipment only as specified or approved by the Project Engineer.

1.2. STANDARDS

The installation covered by these Specifications shall conform to the practices set forth in the latest edition of the National Electrical Code (NEC) and the National Electrical Safety Code (NESC), unless otherwise specified in these Plans and Specifications.

1.3. MATERIALS

1.3.1. All Contractor furnished materials, unless otherwise indicated, shall be new, of the first quality and of the proper type for use intended. When applicable, all material will be in accordance with the latest published NEMA Standards and/or carry the approval of the Underwriter's Laboratories.

1.3.2. The use of a manufacturer's trade name and catalog number is intended to indicate preference. Products of reputable manufacture, equal quality, and functional type may be used only after stamped approval by the Project Engineer.

1.3.3. Owner furnished items, with a general description of the items and their storage location, are listed in the Attachments at the end of this Specification. The Contractor shall coordinate the receiving of the items with the Project Representative. It is the Contractor's responsibility, unless otherwise specified, to furnish labor and equipment for loading, for transporting, and for off-loading the items at the job site.

1.3.4. All material and equipment stored on the substation site or other areas including Owner furnished material and equipment, shall be in the care, custody, and control of the Contractor. The Contractor shall be responsible for any necessary repairs or replacement of materials and equipment damaged, lost, or stolen while in the care and custody of the Contractor.

2. OUTDOOR SWITCHYARD STRUCTURES

The Contractor shall install all substation structures as indicated on the Drawings. Assembly of the structures shall be in accordance with the Manufacturer’s assembly drawings, unless otherwise specified.

2.1. The Owner's Supplier shall furnish the substation structures as a part of the "Structures and Materials" package. It is the Contractor's responsibility, unless otherwise specified in the Appendix, to furnish labor and equipment for receiving, off-loading, and storing these structures at the job site.

2.2. It shall be the Contractor's responsibility to notify the Owner of any damage to the structures and errors in the structure fabrication before and during the installation, so that the Owner may coordinate with the Manufacturer and make good any such damage to the equipment.

2.3. Detailed structural assembly drawings may be inspected at the JEA office in Jacksonville, Florida, by contacting the Project Engineer.

2.4. The steel structures, as shown on the Drawings, will be furnished by the Owner and are fabricated for bolted field assembly. Mounting holes for equipment have been included in the fabrication of the structures.

2.5. The Contractor shall include in the bid and be responsible for the correction of minor errors and minor modifications in the structures in order to provide for a complete installation as indicated on the Drawings. Corrections shall include but not be limited to the following: reaming misaligned holes, punching new holes, and clipping or punching support angles as required. Approximately 100 punched holes shall be considered minor modifications. All modifications shall be cold galvanized to resist corrosion.

2.6. Any equipment mounted on the structures by the Contractor (e.g. AC panels, outlet boxes, etc.) shall be mounted utilizing galvanized or stainless steel materials and hardware. Whenever practical, the Contractor shall mount miscellaneous equipment to the structures using non-penetrating methods such as back-to-back unistrut. All holes drilled to mount such equipment shall be cold galvanized to resist corrosion.

2.7. The Contractor shall provide and install a bit-u-mastic coating for the bases of all aluminum structures which come into direct contact with concrete foundations.

2.8. The Contractor shall install lighting fixtures mounted on the lightning probe poles and on the takeoff structures complete with conduit, wiring, light fixtures, and switches, in locations as shown on the Drawings. Conduit, switches, and wiring as specified on the Drawings shall be furnished by the Contractor.

2.9. Erection of the lightning probe poles shall be in accordance with the Manufacturer's assembly drawings.

2.10. The Contractor shall install perimeter lighting poles complete with anchor bases, arms, conduit, wiring, light fixtures, and photocells in locations as shown on the Drawings. Lighting poles and anchor bases will be furnished by the Owner, as indicated in the Attachments at the end of these Specifications.

2.11. All substation structures and equipment are stored at the Substation Packager's facility. The Contractor shall plan and make provisions for receiving, unloading, and storing on site all related structures and equipment.

2.12. The Contractor shall provide dry storage containers, as required, for all items (including but not limited to cardboard boxes, fragile items, etc.) requiring inside storage until assembly and installation by the Contractor. Tarps and/or covers placed on top of the material and stored outdoors do not qualify as dry storage in this Contract.

3. POWER TRANSFORMERS

3.1. The Owner will be responsible for delivery and offloading the power transformer(s) onto the foundations unless the Contractor fails to have the transformer foundations ready as per Section VII. The Owner will provide the Contractor the desired delivery date when available. The Contractor shall prepare the site and foundations as directed to facilitate off-loading (see Section VII for additional transformer installation requirements). An approximate delivery date for the transformer is listed in Section VII of these Specifications. Crane and Rigging in Jacksonville, Florida, is the only company approved to lift, transport, and set power transformers for JEA.

3.2. The Contractor shall schedule the installation of the transformer foundation to allow for a minimum two (2) week curing time prior to the receipt and installation of the transformer. This will require the Contractor to schedule the installation of the transformer foundation well in advance of the estimated delivery date of the transformer, due to the inherent uncertainties involved in shipping large transformers. Early foundation construction times, and the corresponding longer curing times are strongly recommended.

3.3. The Owner, the Equipment Manufacturer's Contractor, or representative acting as an agent for the Owner, will be responsible for assembly of the power transformer and will furnish and operate the filtering equipment, vacuum drying equipment, provide the insulating oil, and fill the transformer. The Contractor shall provide adequate working space and access to temporary construction power to allow assembly and vacuum oil filling of the power transformers.

3.4. In no instance is a Contractor's employee or agent to enter a transformer manhole unless accompanied by the Owner's representative and only after suitable oxygen analysis has been conducted on the internal equipment environment.

3.5. The power transformers shall be under the care and custody of the Contractor while on the substation site. The Contractor shall be responsible for any minor repairs, as deemed necessary by the Project Engineer, to the finish of the power transformers that may have been damaged while in the care and custody of the Contractor.

3.6. Connections to the power transformers by means of bus or conductor will be the responsibility of the Contractor.

3.7. The foundation, conduit, control and power cabling, grounding, and associated work will be the responsibility of the Contractor.

3.8. All associated primary wiring, secondary wiring, control wiring, and grounding connections shall be furnished and installed by the Contractor in accordance with the Manufacturer's assembly instructions and JEA substation equipment interconnection drawings.

4. CIRCUIT BREAKERS

4.1. The Contractor shall be responsible for either transporting the circuit breakers to the substation site from their storage location at an arbitrary location within Duval County, Florida, or receiving all circuit breakers directly from the Manufacturer at the job site at the discretion of JEA.

4.2. The following tasks must be performed if the breaker is being shipped directly to the job site:

4.2.1. The Contractor may assume that the Owner’s Manufacturer shall have the breakers available for shipping in time to meet the scheduled circuit breaker shipping dates which are shown in the Project Schedule in the Attachments of these Specifications.

4.2.2. As the project progresses, the Contractor shall notify the Project Engineer in writing (or by electronic mail) at least two (2) weeks in advance of the date of the Contractor’s readiness for the breakers. This should be at the time of foundation pouring, to assure sufficient time for curing, and should conform to the breaker delivery dates listed in the Project Schedule in the Attachments of these Specifications.

4.2.3. The Owner’s Manufacturer will then ship the breakers directly to the job site and deliver it on the date specified by the Contractor, +/- five (5) business days.

4.2.4. The Contractor shall then have employees and equipment on-site during business hours, throughout this five day window, to off-load the breaker within one (1) hour of the shipper’s arrival. The Contractor shall then take responsibility of the breaker, and may choose whether to set the breaker directly onto

the pad or to set the breaker in an approved storage area. Approved storage areas shall mean any storage location approved by the Project Representative for this specific purpose.

4.2.5. The Contractor shall be responsible to ground the circuit breaker (including each high-voltage bushing) immediately upon arrival at the job site. This may be done by means of a temporary attachment to the ground grid, when approved by the Project Representative. The Contractor shall also run temporary AC power to the heater in the control panel of each breaker.

4.3. The Contractor shall be responsible for some minor assembly of the breaker at the job site. This assembly, which shall be supervised by JEA personnel, shall include such things as assembly of supports, attachments of control panel doors, etc. The Owner shall supply the Contractor with one (1) copy of the Manufacturer's assembly instructions. The Contractor shall closely follow these instructions.

4.4. The Owner, the Equipment Manufacturer's Contractor, or representative acting as an agent for the Owner, will furnish and operate the filtering equipment, vacuum drying equipment or SF-6 gas handling equipment, and provide the insulating oil or SF-6 gas. The Owner will be responsible for filling and final adjustment of the circuit breakers.

4.5. The Contractor shall be responsible for the placement of the circuit breakers on the foundations. The Contractor shall install the circuit breakers such that the lowest point of any energized parts is not less than the appropriate above grade clearance for personnel safety (NESC) above the foundation elevation.

4.6. Connections to the circuit breakers, by means of bus or conductor, will be the responsibility of the Contractor.

4.7. The foundation, conduit, control and power cabling, grounding, and associated work will be the responsibility of the Contractor.

4.8. All associated primary wiring, secondary wiring, and control wiring, and grounding connections shall be installed by the Contractor in accordance with the Manufacturer's assembly instructions, unless directed otherwise on the construction drawings.

5. CIRCUIT SWITCHERS, SWITCHES, & LOAD BREAK DEVICES

5.1. The Contractor shall install circuit switchers, group-operated switches, ground switches, load break devices, hookstick disconnect switches, and fuse disconnect switches as indicated on the Drawings.

5.2. The circuit switchers, group-operated switches, ground switches, load break devices, hookstick disconnect switches, and fuse disconnect switches will be furnished by the Owner's Supplier as a part of the "Structure and Materials" package. The Contractor shall receive, off-load, and store these switches in the same manner as described for the "Structures and Materials" package, unless otherwise directed.

5.3. The Contractor shall adjust and align all switch blades and contacts according to the Manufacturer's recommendations.

5.4. All load break devices shall be installed according to the Manufacturer's recommendations. The Contractor shall be responsible for the re-alignment of switch blades and contacts.

5.5. All operating handles shall be aligned such that the mechanism may be locked in the "OPEN" or "CLOSED" position.

5.6. The minimum clearance between contacts of each pole in the open position shall be adjusted to meet the requirements of NESC and NEMA standards.

5.7. The Owner's responsibility will be limited to inspection and acceptance of switch and operator alignment. Final alignment or adjustment shall be by the Contractor.

5.8. The Contractor shall assist and provide equipment required for the factory servicemen to perform testing, final checkout, and approval of placing the circuit switcher in service.

5.9. The Contractor shall ensure that all control and power (AC and DC) cables are installed and in service prior to the requesting that JEA perform testing and final checkout.

6. MOTOR OPERATING MECHANISM

Motor operating mechanisms shall be furnished by the Owner's Supplier as a part of the "Structures and Materials" package and installed by the Contractor in accordance with the Manufacturer's assembly instructions. The Contractor shall receive, off-load, and store these switches and mechanisms in the same manner as described for the "Structures and Materials" package, unless otherwise directed.

7. INSULATORS, BUSWORK, & CONNECTORS

7.1. The station type insulators, bus, conductor, and connectors shall be furnished by the Owner's Supplier as listed in the Bill of Materials as a part of the "Structures and Materials" package and installed by the Contractor in accordance with the Manufacturer's assembly instructions. The Contractor shall receive, off-load, and store this equipment in the same manner as described for the "Structures and Materials" package, unless otherwise directed. That includes providing dry storage for the material, boxes, crates, cartons, etc. not suited for outdoor storage.

7.2. The Contractor shall install station type insulators, bus, conductor, and connectors as indicated on the Drawings.

7.3. Any chipped or damaged insulators shall be brought to the Owner's attention prior to installation. The Contractor shall repair minor insulator damage after review of the damage and approval of the Contractor's proposed repair process is made by the Project Engineer.

7.4. The minimum clearance between bus and overhead conductors of different phases and from conductors to ground shall be as indicated on the Drawings. Where not specifically indicated, the minimum clearances shall be as indicated on the General Notes Drawing.

7.5. The Contractor shall install all bus, conductors, and connectors as indicated on the Drawings. All items on the substation structures, including hardware, will be furnished by the Owner's Supplier unless noted otherwise on the Bill of Materials or on the Drawings.

7.6. The welding of aluminum bus shall adhere to the following requirements:

7.6.1. The welding process and all welding operators shall be qualified in accordance with the Aluminum Association Aluminum Construction Manual, "Specifications for Aluminum Structures", Section 7/2/4 (Qualification of Welding Procedure and Welding Operators).

7.6.2. All joints to be welded shall be free of moisture and hydrocarbons. Degreasing shall be done with a non-toxic solvent. Sufficient time must be allowed for the evaporation of the solvent prior to welding. Wire brushing with a stainless steel wire brush should be employed after solvent cleaning to remove all oxide films, water stains, etc.

7.6.3. All aluminum welds shall be by the gas metal-arc (MIG) or the gas tungsten-arc (TIG) welding process.

7.6.4. The working area should be substantially draft-free and protected from atmospheric contamination.

7.6.5. All welds shall be made with clean metal and the completed weld shall have a smooth finish and shall indicate good fusion with the parent metal.

7.6.6. All connections shall be checked for the proper edge penetration and alignment before, during, and after the weld is made. The cross sectional area of the weld should not be less than that of the smallest member being joined.

7.6.7. To repair a defective weld, the defective portion must be entirely removed. The area to be repaired should be re-cleaned as in Paragraph 7.6.2 above and the weld made in a manner similar to the original.

7.6.8. Tackwelding should be used to prevent misalignment of the members being joined during the welding process.

7.7. Tinned connectors shall be installed when a copper to aluminum connection is made. The tinned connectors shall be furnished by the Owner.

8. INSTRUMENT TRANSFORMERS, POTENTIAL TRANSFORMERS, & LIGHTNING ARRESTORS

8.1. The instrument transformers, potential transformers, and lightning arrestors will be furnished by the Owner's Supplier as a part of the "Structures and Materials" package. The Contractor shall receive, off-load, and store these materials in the same manner as described for the "Structures and Materials" package, unless otherwise directed.

8.2. The Contractor shall install outdoor instrument transformers and potential transformers as indicated on the Drawings. All wiring shall be as listed in the Cable Schedule and Conduit Schedule.

8.3. The Owner will furnish, operate, and supervise the filtering equipment and oil for the instrument transformers as required.

8.4. The Contractor shall install lightning arrestors as indicated on the Drawings.

8.5. All associated primary wiring, secondary wiring, instrument and control wiring, and grounding connections shall be installed by the Contractor in accordance with the Manufacturer's instructions, unless stated otherwise in the Drawings.

8.6. Tinned connectors shall be installed when a copper to aluminum connection is made. The tinned connectors shall be furnished by the Owner.

9. STATION SERVICE, AUTOMATIC TRANSFER SWITCH, & ELECTRICAL PANELS

9.1. The Contractor shall be responsible for transporting and installing the Owner furnished distribution type transformers in the locations as shown on the Drawings. The transformers are located at the JEA Commonwealth Service Center and will be taken out of stock.

9.2. The Contractor shall be responsible for transporting and installing the automatic transfer switch if specified on the Station Service Drawing. The transfer switch shall be ASCO Type 940 or 7000 and be furnished by the Owner complete with a NEMA 3R enclosure. The Contractor shall furnish and install galvanized unistrut channels and stainless steel mounting hardware as required to mount the transfer switch to the structure mounting brackets.

9.3. The Contractor shall be responsible for installing three phase CTs and Meter in accordance with JEA electric service standards and as shown on the Drawings.

9.3.1. The Owner will furnish three (3) CTs (item# METCT001) and one (1) meter socket (item # METSO007). The Contractor shall supply all other materials needed to complete the service metering.

9.3.2. The CTs, CT cabinet and meter socket/enclosure shall be grounded in accordance with the NEC and local inspection authority requirements. Cabinet shall be capable of being sealed and/or locked by the JEA meter shop activity.

9.3.3. Conduits entering CT cabinet from point of service shall be marked “Line” and conduits leaving CT cabinet to Main Breaker Panel (MBP) “Load”.

9.3.4. CT#3 to contain the high leg, marked with orange phasing tape and be the right-most CT in the CT cabinet.

9.4. The Contractor shall furnish and install all new AC electrical panels on the load side of the automatic transfer switch as shown on the Drawings, unless directed otherwise. The Contractor shall also furnish and install the internal circuit breakers, ground bus, and associated hardware (as required) to complete the wiring shown on the panel drawing. The Contractor shall also furnish and install the galvanized unistrut channel and stainless steel mounting hardware as required to mount the panel to the structure mounting brackets.

9.5. The Contractor shall be responsible for furnishing the necessary terminals, connectors, etc., to terminate cables at the transformers, ATS, and splices (as required).

9.6. The Contractor shall be responsible for furnishing and installing the switchyard electrical panels, cabinets, and junction boxes. The exact quantity, locations and sizes of the panels, cabinets, and junction boxes shall be as shown on the Drawings. All switchyard AC panels shall be enclosed in stainless steel enclosures.

9.7. The AC power panelboards shall be Square D Co. Type NQOD. All panelboards shall be enclosed in a NEMA 3R enclosure and shall also include housings with a lockable cover and/or door.

9.8. The Contractor shall be responsible for furnishing and installing the main and branch circuit breakers in all yard panels. The main breakers and branch circuit breakers shall be conventional bolt-on type circuit breakers rated in accordance with the Drawings. The wiring and labeling of each panel breaker shall be as shown on the Drawings and in accordance with other applicable Sections of these Specifications.

9.9. The Contractor shall be responsible for securely mounting switchyard electrical panels to the substation structures. Mounting brackets may have been incorporated into the structure design. The Contractor shall furnish and install galvanized unistrut channels and stainless steel mounting hardware as required to mount the electrical panels, cabinets, and junction boxes to the structure mounting brackets. Should any alteration or modification be necessary for the mounting of electrical panels, the Contractor shall submit details of the proposed alteration to the Project Engineer in writing for approval prior to installation.

10. SWITCHYARD RECEPTACLES

10.1. The switchyard receptacles shall be furnished by the Contractor.

10.2. The Contractor shall be responsible for installing the yard receptacles and the vacuum pump receptacles. Installation and wiring of each receptacle shall be in accordance with the Drawings. Details for mounting the switchyard receptacles (if applicable) are included in the Drawings.

10.3. The 120V (single phase) yard receptacles shall be standard grounding type duplex receptacles mounted in a weatherproof outlet box with a weatherproof cover, Crouse-Hinds catalog number WLRD-1 or approved equal.

10.4. The 240V (single phase) truck receptacles shall be Thomas & Betts/Russellstoll Type SCA, catalog number 3323-78 or approved equal.

10.5. The 240V (three phase) vacuum pump receptacles shall be Thomas & Betts/Russellstoll Type SCA, catalog number 3324-78 or approved equal.

10.6. All above grade conduit to the receptacles shall be either rigid galvanized steel or UV resistant PVC, Schedule 40.

11. SWITCHYARD RELAY BOXES

11.1. The Contractor shall be responsible for furnishing and installing the bus differential boxes, potential transformer fuse boxes, terminal blocks, fuse blocks, test switches, and heaters (as specified). The exact quantities, locations, sizes, and types of boxes, blocks, switches, and heaters shall be as shown on the Drawings. The bus differential and PT fuse boxes shall be stainless steel.

11.2. The Contractor shall be responsible for securely mounting the switchyard relay boxes to the substation structures. Mounting brackets may have been incorporated into the structure design for most of these boxes. The Contractor shall furnish and install galvanized unistrut channels and stainless steel mounting hardware as required to mount the relay boxes to the structure mounting brackets. Details for mounting and wiring the switchyard relay boxes (if applicable) are included in the Drawings. Should any alteration or modification be necessary for mounting the relay boxes, the Contractor shall submit details of the proposed alteration to the Project Engineer for approval prior to installation.

11.3. All above grade conduit to the relay boxes shall be either rigid galvanized steel or UV resistant PVC, Schedule 40. Installation and termination of control and instrument wiring shall be in accordance with the Specifications and Drawings.

12. CONSTRUCTION STATION SERVICE

The Contractor shall be responsible for installing and maintaining a temporary station service facility for new construction and additions to existing stations where adequate facilities are not available.

12.1. The Contractor shall be responsible for following standard permitting and application procedures to obtain the construction service. Where the installation of a power transformer or autotransformer is required, the construction service shall be 3-phase. The Contractor's service is to be metered and shall comply with JEA requirements for meter can, weatherhead, and disconnect.

12.2. The Contractor shall provide the necessary conduit, cable, entrance head, meter, disconnect switch, panels, outlets, etc. to sufficiently supply electric service to the field office, construction outlets, and permanent low-voltage receptacles for station check-out.

12.3. The Owner will provide the distribution lateral, temporary span poles and distribution transformers as required for the construction station service. The Contractor shall be responsible for furnishing and installing secondary conductors and raceway to the transformers as required.

12.4. The Owner will be responsible for the total metered electric charges of the construction service during the term of the Construction Contract.

12.5. The Contractor shall provide a 200A disconnect in a NEMA 3R enclosure to run conduit and cables to the permanent station service facilities for use in equipment check-out by the Owner. The Contractor shall furnish and install conduit to the cable trench, or permanent facilities, and install single conductor 4/0 RHW cable to the

ATS or AC panels (as required). This requirement is in addition to the Contractor's service and shall be provided as soon as the low-voltage equipment is in place (see Section VII, Subsection 2, for Sequence of Work).

NOTE: Termination of the permanent station service transformers to the ATS or low-voltage electrical panels shall not be performed until after the temporary service has been disconnected.

12.6. The Contractor will be required to remove any temporary construction service poles and the construction service once the substation is energized and the permanent station service is in operation. Additionally, the Contractor shall apply for removal of the service drop and transformer bank.

12.7. Where there is existing station service available, and JEA service requirements are met, the Contractor shall be allowed to utilize the station service for construction A.C. at no cost.

13. GROUND GRID SYSTEM

13.1. GENERAL

13.1.1. This is a general specification and covers the requirements and procedures for the installation of, or addition to, the station ground grid system. Any material or equipment listed which does not apply to this particular project shall be disregarded. The Drawings shall be referenced for specific requirements concerning the quantity, type, and installation of the material to complete the station ground grid system.

13.1.2. The Contractor shall be responsible for providing the Owner with an accurate "As Built" drawing of the station ground grid (as specified in Section VII, Subsection 5).

13.2. SCOPE

This Section covers the labor, equipment, and material requirements for the installation of, or addition to, the station ground grid system. The Contractor shall install the ground grid, ground rods, and ground wells as shown on the Drawings and herein specified. The Contractor shall also be responsible for the connection of all switchyard electrical equipment, control house electrical equipment, substation structures, fences and gates to the station ground grid system as shown on the Drawings and herein specified.

13.3. MATERIALS

The Contractor shall refer to the Drawings for material requirements to complete the station ground grid system. The Contractor shall furnish materials and equipment only as specified or approved by the Project Engineer.

13.3.1. All Contractor furnished materials, unless otherwise specified, shall be new, of first quality and of the proper type for the use intended.

13.3.2. The Owner shall furnish above grade structure and equipment grounding connectors, unless otherwise indicated. The above grade structure and equipment grounding connectors will be furnished by the Owner's Supplier as a part of the "Structures and Materials" package. The Contractor shall receive, off-load, and store these items in the same manner as described for the "Structures and Materials" package. The Contractor shall furnish the below and above grade ground grid conductor; below grade connectors; the equipment, structures, manhole, and fence grounding conductor; and all fence grounding connectors. The Contractor shall also furnish the grounding system as shown on the Drawings for any "sliding-type" main entrance gate.

13.4. GROUND GRID

13.4.1. The Contractor shall furnish the required amount of 19#8 and 7#5 Copperweld conductor and the 500MCM copper conductor for the ground grid, unless otherwise specified. The Contractor shall purchase the grounding material which meets or exceeds JEA material requirements. The 19#8 conductor (JEA #COBCW015) shall be Copperweld, 19-strand #8, .0643" diameter, 40% conductivity as per ASTM B-227 and B-228, high strength – 27,548 lbs. The 7#5 conductor (JEA #COBCW016) shall be Copperweld, 7-strand #5, .0546" diameter, 40% conductivity as per ASTM B-227 and B-228, high strength – 17,949 lbs.

13.4.2. The Contractor shall install the ground conductor in the locations indicated on the Drawings and at the depth specified. The Contractor shall install the conductor in an open trench to facilitate proper installation and inspection of the ground grid connections.

13.4.3. The Contractor shall notify the Owner of any damaged ground grid conductor before, during, and after installation so the conductor may be replaced.

13.4.4. The Contractor shall furnish material (as required) and install all ground rods, ground wells, and grounding connections to complete the ground grid system, as specified.

13.5. GROUND RODS AND GROUND WELLS

13.5.1. The Contractor shall furnish and install ground rods and ground wells (as specified) in the locations shown on the Drawings. Rods and wells shall be specified by either the depth or resistance required. Details for ground rod connections (if applicable) are included in the Drawings.

13.5.2. Where the installation of ground rods and ground wells is specified by depth or where driving rods in soil of high resistivity, it may be necessary to use casing in the well holes. The Contractor shall make a resistance reading of each ground rod and/or ground well prior to its connection to the station ground grid and report these readings to the Project Engineer for verification of the ground grid design. Connection of the rod to the station ground grid shall be made, only after Owner approval, utilizing the exothermic process. The Contractor shall also include these readings on the "As Built" Drawings.

13.5.3. Where the installation of ground rods and ground wells is specified by resistance, the Contractor shall install the ground rods and ground wells to a minimum, base bid depth of fifty (50') feet, unless otherwise specified. The Contractor shall continue until the specified resistance is achieved. A unit price of $3.75 per foot installed will be used for adjusting the contract price from the base bid depth.

13.5.4. All ground rods and ground wells shall maintain a minimum earth cover as specified on the drawings.

13.5.5. Where the installation of ground rods is not specified by resistance or depth, the Contractor shall install ground rods twenty-four (24') feet deep at all locations as shown on the substation grounding drawing. No ground rods or wells shall be installed under paved roadway areas.

13.6. GROUND GRID CONNECTIONS

13.6.1. Ground grid connections (including connections to ground rods and ground wells) shall be made by approved an exothermic process utilizing Cadweld Plus molds and materials manufactured by Cadweld. The Contractor shall use the Cadweld Plus System with the corresponding molds and electronic control unit for weld metal ignition. Molds for each type of connection are to be replaced after a maximum use of fifty (50) welds.

13.6.2. Ground grid connections shall be of the type that avoids cutting and/or splicing of the main grid conductor.

13.6.3. A Manufacturer's representative is required to demonstrate the proper installation procedures of the exothermic system being used prior to installation of any ground grid connection. The Contractor shall be responsible for arranging the demonstration. Any Contractor representative that may install the ground grid connections and the Project Representative shall be present at the demonstration.

13.6.4. The Contractor shall strictly follow the Manufacturer's installation procedures.

13.6.5. All surfaces to be joined by the weld shall be thoroughly cleaned and dried prior to final placement of the mold. Worn, damaged, or incorrectly sized molds which in the opinion of the Project Representative do not make satisfactory welds shall be removed from the job site.

13.6.6. All welded connections made by the exothermic process shall encompass 100% of the end of the material being welded. Welds which do not meet this requirement shall be remade at the Contractor's expense.

13.6.7. All welded connections made by the exothermic process shall be visually inspected by the Project Representative and may be subjected to testing. Testing shall be in the form of moderate hammer blows, from which a properly formed connection will easily resist any visible damage. Any connection which fails such a test or which, upon visual inspection, indicates a porous or deformed weld shall be remade at the Contractor's expense. Should different molds or materials be required to facilitate the corrected connection of a failed weld, such material shall be furnished at the Contractor's expense. The use of molds and materials other than specified must be approved for use by the Project Engineer.

13.7. TRANSFORMER GROUNDING

13.7.1. The Contractor shall connect the neutral bushing of any power transformer or autotransformer directly to the station ground grid using 500MCM copper conductor. The neutral ground conductor shall extend continuously and be connected to the station ground grid in two (2) places using the connection process specified. The two (2) connections shall be made to the same ground grid run and shall be placed approximately three (3') feet apart.

13.7.2. The Contractor shall connect the transformer tank to the ground grid in two (2) locations as shown on the Drawings using 7#5 Copperweld conductor and the connection process specified.

13.7.3. The Owner shall furnish the above grade grounding connectors to be used in connecting the power transformers to the ground grid. The Contractor shall furnish the 500MCM copper and the 7#5 Copperweld grounding conductor to be used in connecting the power transformers to the ground grid system.

13.8. SWITCH GROUNDING

13.8.1. All group operated switches shall be furnished by the Owner complete with an operator platform. The operator platform shall be located on the rocked surface as indicated by the Drawings and be connected on one side to the station ground grid. A continuous grounding conductor shall extend from the other side of the operator platform through the parallel ground clamp, provided for structure grounding, to the operating mechanism. This conductor shall be connected to the operating pipe by means of a flexible copper braid. The remaining groove of the parallel grounding clamp shall contain a conductor connected directly to the station ground grid. All mechanical connectors used in this installation shall be furnished by the Owner. Details for grounding the operator platform (if applicable) are included in the Drawings.

13.8.2. Every switch structure shall be connected to the station ground grid in at least two (2) locations, as shown on the Drawings. One (1) switch structure ground conductor shall be installed as specified above.

13.8.3. Grounding switches shall have a continuous ground conductor from the blades to the station ground grid. This conductor shall be routed on the structure column opposite of the operating mechanism to facilitate complete grounding of the switch structure. The operating pipes for both the line and ground switches shall be connected by flexible copper braid as specified above.

13.9. EQUIPMENT GROUNDING

13.9.1. The Contractor shall be responsible for connecting electrical equipment such as circuit breakers, station service transformers, potential transformers, instrument transformers, lightning arrestors, etc., directly to the station ground grid as shown on the Drawings.

13.9.2. Electrical equipment shall be furnished by the Owner, unless otherwise specified. The Contractor shall be responsible for installing the equipment ground conductor on the side of the structure designed to accommodate the ground conductor.

13.9.3. The Owner shall furnish all above grade ground connectors necessary to connect the equipment to the station ground grid, unless otherwise specified. The Contractor shall furnish the 7#5 Copperweld grounding conductor and all other material, equipment, and labor necessary to complete the connection of the electrical equipment to the station ground grid.

13.9.4. The Contractor shall install the equipment ground conductor such that the continuity of the conductor from the equipment to the station ground grid is maintained as much as practical.

13.9.5. The ground conductor installed on the equipment structures shall be sufficient in meeting the requirements of structure grounding.

13.9.6. Free standing electrical equipment, such as circuit breakers, shall be connected directly to the station ground grid. The Contractor shall install ground conductors as shown on the Drawings. More than one (1) ground conductor installation may be required in the grounding of free standing electrical equipment.

13.10. STRUCTURE GROUNDING

13.10.1. The Contractor shall be responsible for connecting all steel structures directly to the station ground grid as shown on the Drawings.

13.10.2. The structures are furnished by the Owner and are designed to accept the ground connectors provided. The Contractor shall be responsible for installing the structure ground conductor on the proper side of the structure to facilitate the connection of the structure to the station ground grid.

13.10.3. The Owner shall furnish all above grade ground connectors necessary to connect the structures to the station ground grid, unless otherwise specified. The Contractor shall furnish the 7#5 Copperweld grounding conductor and all other material, equipment, and labor necessary to complete the connection of the steel structures to the station ground grid.

13.10.4. The Contractor shall install all structure ground conductors such that they conform to the structure and foundation. Ground conductors on structures with grounded equipment shall conform to the requirements of this Section IX and all relevant paragraphs.

13.10.5. Structures must be grounded to the station grid within the same working day the structure is erected.

13.11. CABLE TRENCH AND CONTROL HOUSE GROUNDING

13.11.1. The Contractor shall install the cable trench and control house grounding as specified and shown on the Drawings. The Contractor shall furnish the 7#5 Copperweld conductor necessary to ground the

cable trench and control house to the station ground grid and all other required material and labor to complete the installation.

13.11.2. The Contractor shall install the cable trench and control house ground conductors. The ground conductor shall run the entire length of the cable trench and connect to the station ground grid at all points of intersection. Two (2) ground conductors shall be brought into the control house through the cable trench and attached to the outside of the cable tray. The Contractor shall furnish and install 7#5 Copperweld cable clips on one side of the cable trench to support the ground conductor.

13.11.3. Connection of the ground conductor to the cable tray shall be made utilizing Burndy Type GC2929CT connection or approved equal. The ground conductor shall be secured to the cable tray at each cable tray fitting or at intervals not exceeding four (4') feet throughout the length of the tray. Provide ground wire lugs and hardware (as required). The cable tray shall NOT be used as a ground path.

13.11.4. Control house equipment, including electrical panels shall be connected to the control house ground by means of Anderson Type K3 connector or approved equal.

13.11.5. Where a reinforced concrete floor is installed in the control house, the Contractor shall bond the control house slab reinforcement to the ground grid to provide equipotential surfacing as shown on the drawings. Metal floor decking within modular buildings should be bonded internally by the manufacturer, with connections to the grid on the exterior of the building at the points designated.

13.12. CHAIN LINK FENCE AND GATE GROUNDING

13.12.1. The Contractor shall furnish the material and connect the chain link fences to the station ground grid as specified and as shown on the Drawings. Details for grounding the fence and fence gates, if applicable, are included in the Drawings.

13.12.2. The Contractor shall connect the fence to the station ground grid at every gate post, every corner post, and intermediate posts at convenient intervals, no more than forty (40') feet apart. The fence and gate posts shall be connected to the station ground grid using 7#5 Copperweld conductors.

13.12.3. The Contractor shall furnish #2 AWG copperweld conductor and connectors as required to complete the fence grounding. The conductor shall attach to the post with a minimum of three (3) clamp connections and be woven into the fence fabric between these connections to terminate on each strand of barbed wire.

13.12.4. Each personnel and equipment swing gate shall have a perimeter ground conductor of 19#8 Copperweld connected to the station ground grid. This conductor shall extend approximately three (3') feet beyond the gate swing, both inward and outward, unless property restrictions prevent the exterior extension.

13.12.5. Each swing gate leaf shall be connected to the gate post with a copper welding cable, as specified on the Drawings. The copper welding cable and exothermic weld connections shall be furnished by the Contractor. The Contractor shall connect the welding cable directly to the post and the post grounding conductor.

13.12.6. The Contractor shall furnish and install the grounding system as shown on the Drawings for the substation lift and/or sliding entrance gates.

14. CONDUITS, CABLE TRENCHES, & CABLE TRAYS

14.1. GENERAL

14.1.1. This is a general specification and covers the requirements and procedures for the installation of conduits, wireways, cable trenches, and cable trays used to distribute power and control cables to the equipment in the switchyard and control building. Any material or equipment listed which does not apply to this particular project shall be disregarded. The Drawings shall be referenced for specific requirements concerning the quantity, type, and installation of material to complete this work.

14.1.2. The Contractor shall be responsible for providing the Owner with accurate "As Built" drawings of the conduit, cable trench, and cable tray systems installed (as specified in Section VII, Paragraph 5).

14.2. SCOPE

This Section covers the labor, equipment, and material requirements for the installation of conduits, wireways, cable trenches, and cable trays in the switchyard and control building. The Contractor shall furnish all materials necessary and install the conduits, wireways, cable trenches, and cable trays as shown on the Drawings and specified herein.

14.3. MATERIALS

The Contractor shall refer to the Drawings for material requirements to complete the installation of the conduits, wireways, cable trenches, and cable trays as required for the substations raceway system. The Contractor shall furnish materials and equipment only as specified or approved by the Project Engineer.

14.3.1. All Contractor furnished materials, unless otherwise specified, shall be new, of first quality, and of the proper type for the use intended.

14.3.2. The Contractor shall refer to the "Conduit Schedule" for specific material requirements of individual raceway runs.

14.3.3. Unless otherwise specified, UV resistant Schedule 40 PVC shall be permitted for underground conduit runs. All above grade conduit shall be either rigid galvanized steel or UV resistant Schedule 40 PVC, unless otherwise specified or as shown on the Drawings.

14.4. CONDUIT AND WIREWAY

14.4.1. The Contractor shall furnish and install the conduits, as listed in the "Conduit Schedule" and as shown on the Drawings.

14.4.2. The Contractor is responsible for all hardware necessary to complete the installation of the conduit system.

14.4.3. When installing conduit in an existing switchyard, the Contractor shall remove and dispose of the existing rock. The Contractor shall not use this rock to cover the completed work-in-place, but shall place new, clean rock onto the work surfaces. Such rock and its placement shall meet the requirements of Section VIII of these Specifications.

14.4.4. When installing conduit in an existing switchyard, the Contractor shall compact the area to the same density, and with similar material, as with the adjacent undisturbed materials. In every such case, the resultant soils will be re-poisoned to eradicate future plant growth, using the herbicide specified in Section VIII of these Specifications. The Contractor shall furnish these herbicides.

14.4.5. Conduits shall be installed at the depth shown on the Drawings, with the area backfilled and compacted to same density as surrounding areas.

14.4.6. The Contractor shall form all above grade conduits to conform to the surfaces of the foundations and structures. Rigid galvanized steel conduit shall be formed using a pipe bender. UV resistant Schedule 40 PVC shall be shaped with a Therm-o-Tools Company combo type, Hotbox bender, or approved equal.

14.4.7. The Contractor shall furnish and install all indoor conduits, junction boxes, switches, and receptacles as specified in the "Conduit Schedule" and as shown on the Control House Drawings. All conduits less 2" shall be concealed within block walls.

14.4.8. The Contractor shall furnish and install the wireway as specified in the "Conduit Schedule" and as shown on the Control House Drawings. The wireway shall be NEMA 1 square wireway, smooth, seam free, without knockouts, and shall have removable covers. The wireway and associated fittings shall be finished with baked satin ANSI 61 gray enamel over phosphatized surface. The wireway shall be manufactured from steel not less than 16 gauge and shall conform to NEMA standards.

14.4.9. The Contractor shall install the wireway in accordance with the Manufacturer instructions and as indicated on the drawings. All field cuts shall be made with a hacksaw and grounded smooth. Terminations of the wireway run into the cable tray, electrical panels, or electrical equipment shall utilize a panel adapter. Wireway sweeps consisting of two (2) 45 degree bends shall be used in lieu of one (1) 90 degree bend.

14.4.10. The Contractor will be responsible for labeling all conduits as listed in the "Conduit Schedule". For details, see Subsection "Labeling" of this Section.

14.5. PRE-CAST CABLE TRENCH

The trench system shall consist of precast concrete or fiber reinforced precast concrete framing members, side sections, and removable polymer cover sections assembled to form a completely enclosed trench, except with open earth bottom having a 4" bedding of sand. Polymer modified concrete trench lids are not acceptable.

14.5.1. The Contractor shall furnish and install a precast concrete frame with FIBRELITE lids manufactured by TRENWA, or PLASTIBETON lids manufactured by OLDCASTLE, or similar products.

14.5.2. The installation of the cable trench shall be in strict accordance with the Drawings, these Specifications, and the Manufacturer assembly drawings.

14.5.3. The trench shall be dimensioned as shown on the Drawings. A sixteen (16") inch nominal depth shall be furnished, unless otherwise specified.

14.5.4. One-piece trench system with 10'-0" standard lengths shall be furnished.

14.5.5. Precast polymer trench covers shall be furnished in sections, sized to permit removal by a single person, and each shall have slots for lifting tools.

14.5.6. The trench system shall be designed to support at least 200# per square foot live load. The road crossing sections shall be precast with galvanized steel or aluminum lids and designed for H-20 loading.

14.5.7. Precast trench members shall be cast in steel forms using 3000# or greater high early strength concrete. Members shall be cured for a period of at least fourteen (14) days.

14.5.8. The Contractor shall furnish and install all necessary special fittings, offsets, terminations, or other designated fittings (as required).

14.5.9. The Contractor shall furnish and install the cable transition ladder assembly with covers for the trench in the length shown on the Drawings for the entrance to the control house.

14.5.10. Install the concrete trench system in earth trenches with covers extending above the surrounding crushed rock surfacing approximately three (3") inches. See Site Plan for top of trench elevations.

14.5.11. Excavate trenches to a minimum width consistent with the stability of the sides. Excavate completely to the bottom of the framing members and correct any points of over-excavation by returning to grade with mechanically compacted fine earth backfill to form a smooth trench bottom. Remove all excess excavated material as required for proper alignment and elevation of work.

14.5.12. Excavation shall conform to other requirements as set forth in Civil Specifications, Subsection 1 on Site Preparation and Earthwork. Grounding of the cable trench shall conform to the requirements of the Electrical Specifications, Subsection 13.

14.5.13. Component members shall be set only on firm, compacted earth, sand, or gravel mix, at an elevation such that the top of the sidewall will be two (2") inches above the final grade (top of crushed rock) for the substation. Prior to setting the trench section, place geotextile fabric the full length of the trench excavation, overlapping a minimum of two (2') feet at each joint of the fabric. The width of the fabric shall be sufficient to cover the bottom and both sides of the cable trench to finish grade. Geotextile fabric shall be Mirafi 140N, a non-woven water permeable fabric as distributed by:

H. Moore & Associates, Inc.
Maislin Drive, Bldg. E
Tampa, Florida 33637
or approved equal.

14.5.14. After setting the component trench sections, back fill along sides with the geotextile fabric flush against the sides. Place a minimum four (4") inches of bedding sand in the trench to form a level bottom, just covering the bottom of the section members.

14.5.15. Hand tamp the backfill along the outside walls of the trench. Backfill shall conform to other requirements as set forth in the Civil Specifications.

14.5.16. At the trench entrance to the control house, set trench section bottom members on the control house foundation support for trench as provided in the foundation construction. Adjust the end elevation of the section to meet that shown on the Drawing details.

14.5.17. The Contractor shall furnish and install the cable tray transition compartment as designed for the trench as shown on the Drawings. The cable tray transition compartment shall be sealed to the control house wall.

14.5.18. The Contractor shall protect the trench against entrance of construction debris, rock, and earth during the construction and after placing of the sand bedding. The trench shall be cleaned out of any such foreign material prior to placing control cables and just before final placing of covers.

14.5.19. The Contractor shall provide the Owner with a new set of Manufacturer's cover removal tools as well as the tools used during construction. The Contractor shall deliver these tools to the Project Representative.

14.6. CABLE TRAY

The Contractor shall furnish and install the cable tray system located in the switchboard room. The Contractor shall submit a description and/or shop drawings of the proposed cable tray system for approval. The shop drawings submitted shall include certified flexural and loading data with the Manufacturer's recommendation of maximum span for the design load.

14.6.1. Indoor cable trays shall be fabricated from extrusions of aluminum alloy 6063-T5 or 6063-T6. Application shall be in accordance with the ASCE Specifications and AWS Standards. The trays shall be furnished with a six (6") inch depth or four (4") inch depth, as indicated on the Drawings and in nominal twelve (12') foot lengths. Splices shall be of the high pressure bolted type. The design load for the tray installation shall be a minimum 200 lbs. per linear foot for the maximum tray width of thirty-

six (36”) inches or nine (9”) inches, as described on the Drawings, when supported on twelve (12’) foot centers.

14.6.2. Indoor cable trays shall be of the aluminum ladder type with cross rungs spaced six (6”) inches maximum center to center.

14.6.3. All rungs, dropouts and other metal surfaces in contact with the cable shall have smooth, rounded edges. The rungs shall be joined to the sides by a homogeneous union method, weld on swage.

14.6.4. Cable tray supports shall be provided at intervals not to exceed the Manufacturer's recommendations for maximum span for the design load and type of tray being supported. In no case shall the spans exceed that shown on the Drawings.

14.6.5. All necessary splice plates, bolts, nuts, lock washers, etc., shall be furnished compatible for use with the type metal tray provided.

14.6.6. Provide ground wire lugs and hardware as required. The cable tray shall NOT be used as a ground path. Grounding of the cable tray shall conform to the requirements of Section IX, Subsection 13, Paragraph 12.

15. CONTROL CABLE & LOW-VOLTAGE ELECTRICAL CABLE

15.1. CABLE SCHEDULE

15.1.1. The Contractor shall pull and terminate all cables as listed in the Cable Schedule. All control cable, shielded control cable, and instrument cable will be provided by Owner. All other cables listed shall be provided by the Contractor.

15.1.2. Cable lengths listed in the Cable Schedule are approximate and based on engineering estimates that may differ due to field routing or other factors. The total quantities required for the project may also affected by factors such as waste, cable reel sizes and optimization (or lack thereof). The Contractor shall be responsible for the actual quantities required and for verification of all cable lengths prior to cutting.

15.1.3. The Contractor is responsible for providing the Owner with accurate "As Built" revisions of the Cable Schedule, Conduit Schedule, and related Drawings, as specified in Section VII, Subsection 5.

15.1.4. All low-voltage electrical cable furnished by the Contractor shall be as specified in the Cable Schedule. Where multiple conductor cable is specified, the Contractor shall furnish and install multiple conductor cable. Cable lengths listed in the Cable Schedule are approximate. The Contractor shall supply cable as necessary to complete the work.

15.1.5. The Contractor will be responsible for labeling all cables as listed in the Cable Schedule. For details, see Subsection “Labeling” of this Section IX.

15.2. SHIELDED CONTROL CABLE SPECIFICATIONS

15.2.1.

15.3. SPLICES

15.3.1. All runs of control cable shall be continuous. Splices in control cable shall NOT be permitted.

15.3.2. Splices made in low-voltage electrical cable should be avoided. When necessary, splices in low-voltage electrical cable shall conform to all applicable NEC and NESC standards.

15.4. INTERCONNECTION DRAWINGS

The control cable Interconnection Drawings will be supplied at a later date by the Owner to show all terminations of the cables as listed on the Conduit and Cable Schedules.

15.4.1. The Contractor shall be responsible for terminating all cables listed on the Conduit and Cable Schedules. The Contractor shall also be responsible for the termination of any jumpers on terminal blocks in the equipment or on the control panels that may be shown on the Interconnection Drawings.

15.4.2. The Bid shall be based on the assumption of a termination at both ends of every conductor in each cable of the Cable Schedule and an additional fifty (50) #10 cables with 500 total terminations between panels and/or control house equipment. These jumpers may be Class B multi-conductor cables running between panels, including termination.

15.4.3. The Owner shall terminate all cables to existing control panels which are energized. The Contractor shall pull cables to these panels, fan ends, install terminals, and leave ample cable for making terminations.

15.5. CONTROL CABLE TERMINALS

Ring type compression terminals, which shall be furnished by the Contractor, shall be used at both ends of all control cables and wiring. The ring terminals used shall be non-insulated, tin plated, barrel type with brazed seam and sized for the wire being terminated.

15.6. GROUNDING OF SHIELDED CONTROL CABLE

A terminal block has been provided at the top of each relay control panel for terminating the ground conductor of each shielded control cable. Each ground conductor from the shielded cables will land individually on a terminal space, and be identified with its appropriate cable name. The Contractor shall provide amp type Termi-foil connectors for jumper connections between the control cable shields to the panel ground terminal block. The jumper wire size shall be a stranded #10 AWG.

15.7. LENGTH OF CABLES FOR CONTROL PANELS

All cables pulled to the control panels shall be sized to reach the floor of the panel and back to the top of the relay panel or RTU. The insulation jacket shall then be stripped back to the top of the panel and all cables terminated without cutting individual wires.

16. CONTROL HOUSE ELECTRICAL

16.1. SCOPE

This Section covers the equipment, installation, and wiring necessary for the control house.

16.2. GENERAL

The Contractor shall furnish and install the low-voltage equipment in locations as shown on the Drawings. The installation of low-voltage wiring of this equipment shall conform to the practices set forth in the latest edition of the NEC, unless otherwise specified in these Plans and Specifications. It shall be the Contractor's responsibility to furnish the required quantity of conduit and cable necessary to complete the installation.

16.3. EQUIPMENT AND MATERIALS

16.3.1. All materials, unless otherwise indicated, shall be new, of the first quality, and of the proper type for the use intended. Where applicable, all material shall be in accordance with the latest published NEMA Standards and/or carry the approval of the Underwriters' Laboratories.

16.3.2. The use of a manufacturer's trade name and catalog number is not intended to indicate preference, but only the type and quality of the product desired. Products of reputable manufacturers of equal quality and functional type will be acceptable upon approval of the Project Engineer. Substitutes which tend to lower the quality of the work will not be permitted.

16.4. PLACING EQUIPMENT IN SERVICE

Equipment and electrical circuits shall be checked and tested prior to energization. Notification of the Contract Administrator is to be made before energization of the low-voltage electrical equipment so a representative of the Contract Administrator will be present.

16.5. CONTROL HOUSE ELECTRICAL PANELS

16.5.1. The Contractor shall be responsible for furnishing and installing the control house electrical panels. The exact quantity, locations, and sizes of the panels shall be as shown on the Drawings.

16.5.2. The AC panel shall be Square-D Company Type "NQOD" or an approved equal. The panelboard shall be enclosed in a NEMA 1 enclosure and include lightning protection. The panels shall include a lockable cover and/or door.

16.5.3. The DC panel shall be Square-D Company I-Line Type "HCN" or an approved equal. The panelboard shall be enclosed in a NEMA 1 enclosure. The panels shall include a lockable cover and/or door.

16.5.4. The main breakers and branch circuit breakers shall be conventional bolt on type circuit breakers rated in accordance with the Drawings. The wiring and labeling of each panel breaker shall be as shown on the Drawings.

16.6. CONTROL HOUSE LIGHTING AND OUTLETS

16.6.1. The Contractor shall furnish and install the lighting fixtures for the control house; see Drawings for quantities, types and locations. NOTE: All lighting shall operate at line voltage of 120 volts.

16.6.2. Each exterior lighting circuit shall be dawn-dusk controlled by a single photocell mounted on the exterior of the control house.

16.6.3. The Contractor shall furnish and install the following items as needed to complete the Control House Electrical as shown on the Drawings:

A. Receptacle, ground-type duplex, surface mounted.

B. Receptacle, ground fault circuit-interrupter, duplex, surface mounted.

C. Three way switch, surface mounted.

D. Four way switch, surface mounted.

E. Single pole switch, surface mounted.

F. Junction boxes.

G. Conduit, EMT, PVC, and aluminum, as required.

H. Weatherproof covers for all outdoor switches and receptacles.

I. Smoke detector GE Type 350CX with Form A and C output relays.

16.7. CONTROL HOUSE HVAC EQUIPMENT

16.7.1. The Contractor shall furnish and install, as shown on the Drawings, Trane 2.5 ton packaged split system heat pump with heat strips as follows:

(2) Trane 2/4TEC3F30B1000A Air Handler Unit
(2) Trane 2TWB3030A1000A Condensing Unit
(2) Trane BAYHTR1405000A, 4.8kW Electric Heater
(2) Single Stage Heating/Cooling Programmable Thermostat
(2) Trane TAYPLNM100 Plenum Pedestal Upflow

NOTE: Refer to the Control House Electrical drawing for exact number and locations of the condensers and air handlers. For further details or contact information about this equipment, contact the Project Engineer.

A. The Contractor shall furnish and install ducting, return and supply air grills, and permanent type filters associated with the heat pumps above. The Contractor shall also furnish and install a turning vane to efficiently project air into the control house.

B. For each heat pump specified above, the Contractor shall furnish and install two (2) non-fusible, 2-pole heavy duty disconnect safety switches, 60A, 240VAC, one (1) shall use an indoor NEMA 1 enclosure and one (1) shall use a rain tight NEMA 3R enclosure, the disconnect safety switches shall be manufactured by Square-D Company. After the Contractor has installed each heat pump specified above, the Contractor shall complete the conduit run from the disconnect safety switches to the heat pump units, utilizing a section of liquid-tight flexible conduit sized appropriately for connection to the heat pump units. The Contractor shall then complete the power wiring from the disconnect safety switches to the heat pump units.

16.7.2. The Contractor shall furnish and install one (1) wall mounted exhaust fan (Nutone Model #8070SA with Model #834 washable permanent aluminum-mesh filter, or approved equal) in the bathroom.

16.7.3. The Contractor shall furnish and install one (1) wall mounted exhaust fan, explosion-proof, having a capacity of 100 cfm at 0.375 inch wg static pressure with backdraft damper and wall cap in the battery room. Return register with opposed blade dampers shall be provided and adjusted to balance exhaust airflow to 100 cfm. The Contractor shall submit for approval the battery room exhaust fan and associated equipment. Both wall mounted exhaust fan motors shall be suitable for 120V, single phase, 60Hz operation.

16.8. BATTERY BANK, CONTROL SWITCHBOARD PANELS, & SCADA RTU CABINET

16.8.1. The Owner will furnish two (2) battery banks, two (2) tier battery racks and two (2) battery chargers. The Contractor shall transport the above material from the JEA Commonwealth Service Center warehouse to the jobsite, unload, and store them indoors until assembly by the Manufacturer. The Contractor shall move the material to the control house battery room, upon completion of the battery room, for installation by the Manufacturer.

16.8.2. The Contractor shall install the battery chargers, conduits, AC and DC cables, and grounding conductors as required by the Plans and Drawings prior to requesting assembly of the battery banks. The Contractor shall provide a four (4) week notice before requesting the assembly of the battery banks by the Manufacturer. The Manufacturer shall install, float charge, test, and approve the battery bank for in-service operation.

16.8.3. The Contractor shall request delivery schedule, unload, and install the control switchboard panels (quantity as indicated on the Drawings), and pickup, transport, and install one (1) SCADA RTU cabinet in the locations as shown on the Drawings. The Contractor shall install these panels into the Control House only after the Control House is substantially complete, including installation of the floor sealant. The Contractor shall be responsible for properly leveling the panels and ensuring that all access doors are operable.

16.8.4. The Owner will furnish and install all communications, network, and security switchboard panels within the control house.

16.8.5. The Contractor shall be responsible for all additional incurred cost by JEA if the Contractor is unable to unload and place the relay panels into the control house upon delivery from the Manufacturer.

17. RECEIVING AND OFF-LOADING OF STRUCTURES AND MATERIALS

The Contractor shall be responsible for taking delivery of all Substation Structures and Materials directly from the Manufacturer at the job site. This will require that the Contractor perform the following tasks regarding Substation Structures and Materials delivery as the project progresses:

17.1 The Contractor may assume that the Owner's Manufacturer shall have the Substation Structures and Materials available for shipping in time to meet the scheduled Structures and Materials shipping date which is shown in the Project Schedule in the Attachments of these Specifications.

17.2 As the site work progresses, the Contractor shall notify the Project Engineer in writing (or by electronic mail) at least two (2) weeks in advance of the date of the Contractor's readiness for all Structures and Materials. However, this scheduled delivery date must be within two (2) weeks of the scheduled Structures and Materials shipping date which is listed in the Project Schedule in the Attachments of these Specifications.

17.3 The Owner's Manufacturer will then set an approximate schedule for the shipment of all Substation Structures and Materials directly to the job site and deliver on the date specified by the Contractor, +/- five (5) business days (two week window).

17.4 When the shipper of each shipment is within 48 hours of the Substation site, the shipper will contact the Project Representative to schedule a delivery appointment. The Contractor, shipper, and Project Representative shall then coordinate a firm appointment.

17.5 The Contractor shall then have employees and equipment on-site, throughout normal business hours of that day, to off-load all Substation Structures and Materials within two (2) hours of the shipper's arrival. The Contractor shall then take responsibility of all Substation Structures and Materials, and may store the Structures and Materials on-site in an approved storage area. Approved storage area shall mean any storage location approved by the Project Representative for this specific purpose.

17.6 The JEA Project Representative and the Contractor shall then count, examine, and sign for all Structures and Materials.

18. LABELING

The Contractor shall be responsible for labeling the following newly-installed substation facilities at the job site. This will require that the Contractor perform the following tasks:

18.1. LABELING OF LARGE TRANSFORMERS AND BREAKERS

The Contractor shall provide and install all labeling of all newly-installed large transformers and high-voltage circuit breakers in the switchyard as specified below.

18.1.1. The Contractor shall label the transformers and breakers using spray paint and a block stencil with six (6") inch high letters. The equipment designations to be used are shown on the "SINGLE LINE DIAGRAM" Drawing.

18.1.2. The Contractor shall prepare the surface of the transformers and breakers prior to painting, in a manner approved by the Project Representative. The paint shall be Rust-oleum spray on #7776-830, flat black, or equal as approved by the Project Representative.

18.1.3. The labeling shall be applied, at approximately eye level, in two (2) places: on the right hand side of the cabinet door and another location as specified by the Project Representative.

18.2. LABELING OF HIGH-VOLTAGE SWITCHES

JEA shall provide and the Contractor shall install labeling on all newly-installed high-voltage substation switches at the job site. These switches include high-voltage hook switches, group-operated switches, circuit switchers, and fused disconnect switches which interconnect to the buswork. The labeling of these switches will require that the Contractor perform the following tasks:

18.2.1. The Contractor shall apply labels on the switch support structures as enumerated on the Drawing titled "SINGLE LINE DIAGRAM".

18.2.2. The Contractor shall label the switches using reflective labeling to be provided by JEA through the Project Representative. Note that the Contractor must notify the Project Representative in writing (or by electronic mail) when the Contractor is approximately two (2) weeks away from needing these labels. The Project Representative will then pick up the labels from the JEA storeroom and deliver to the Contractor at the job site.

18.2.3. The labeling shall be applied at a location to be field located by the Project Representative, or a JEA employee who is directed by the Project Representative.

18.3. LABELING OF LOW-VOLTAGE PANELS

The Contractor shall provide and install all labeling of all other low-voltage panels installed in the switchyard as well as low-voltage AC/DC power panels in the control house, as specified below:

18.3.1. The Contractor shall label the cover of every newly installed junction box, AC low-voltage supply panels, DC low-voltage supply panels, and others as labeled on the "CONDUIT PLAN" and the "STATION SERVICE AND YARD PANELS" Drawings. This shall also include the AC low-voltage supply panels and DC low-voltage supply panels in the control house.

18.3.2. The Contractor shall label the covers using a block stencil with three (3") high letters.

18.3.3. The Contractor shall prepare a reasonable portion of the surface of such covers and paint the characters onto the surface. Paint shall be Rust-oleum spray on #7776-830, flat black, or equal as approved by the Project Representative.

18.3.4. The labeling shall be applied, at approximately eye level, centered on the cover, or other location if approved by the Project Representative.

18.3.5. The labeling shall also be hand-written inside the panel, to the panel box itself, in a conspicuous location, using a permanent marker. Sharpie Fine Point Series 30000 Black, or approved equal.

18.4. LABELING OF LOW-VOLTAGE AC/DC SUPPLY BRANCHES

The Contractor shall be responsible for labeling of all newly-installed low-voltage AC/DC supply branches at the job site. This will require that the Contractor perform the following tasks:

18.4.1. The Contractor shall label the branch circuits of each AC/DC supply branch to agree with the designations as shown on the "STATION SERVICE AND YARD PANELS" Drawing.

18.4.2. The Contractor shall label the branch circuits of each AC/DC supply branch in two (2) locations; the panel front surface adjacent to the protection device (breaker) and the branch index sheet provided with the cover of the cabinet.

18.4.3. The branch index sheet shall be neatly typed (or clearly printed in ball-point pen) with the branch names shown on the Drawings for these panels. Two (2) copies of this sheet will be produced by the Contractor and provided to either the Project Representative or the Project Engineer at the final checkout / inspection.

18.4.4. The Contractor shall provide and install labels of each branch on the panel front surface adjacent to the protection device (breaker). The Contractor shall refer to the Project Representative for approval of a labeling system for this purpose.

18.5. LABELING OF SWITCHYARD RECEPTACLES

The Contractor shall provide and install labels on all newly-installed switchyard receptacles at the job site. This will require that the Contractor perform the following tasks:

18.5.1. The Contractor shall apply labels on the switchyard receptacle structures as labeled on the "CONDUIT PLAN" Drawing.

18.5.2. The Contractor shall label the switchyard receptacle structures using a block stencil with three (3") high letters.

18.5.3. The Contractor shall prepare a reasonable portion of the surface of such structures and paint the characters onto the surface. Paint shall be Rust-oleum spray on #7776-830, flat black, or equal as approved by the Project Representative.

18.5.4. The labeling shall be applied at a location to be field located by the Project Representative.

18.5.5. Additionally, the Contractor shall label each receptacle on the inside of the receptacle faceplate or cover using a permanent fine-tip black marker. Sharpie Fine Point Series 30000 Black, or approved equal.

18.6. LABELING OF CONDUITS

The Contractor shall provide and install labels on all newly-installed conduits as a part of this work.
This shall require that the Contractor perform each of the following:

18.6.1. Where conduits enter an electrical panel (AC/DC service panel, control panel, junction box, etc.), the Contractor shall label the conduit in two (2) places:

A. The Contractor shall label the conduit circumferentially, about two (2") inches outside of the box, using a permanent fine-tip black marker. The markings shall be positioned and sized so that a person working on the cabinet may readily see the markings.

B. The Contractor shall also apply the same labels, using a permanent fine-tip black marker, on the interior of the box, conspicuously near the conduit entry points.

18.6.2. Where conduits enter a cable trench, the Contractor shall label the conduit along the axis of the conduit, about two (2") inches below the conduit opening, using a permanent large-tip black marker. The markings shall be positioned and sized so that a person looking downward onto the conduit may readily see the markings.

18.6.3. Where a conduit terminates other than as mentioned above, the Contractor shall label the conduit along the axis of the conduit, about two (2") inches below the conduit termination, using a permanent large-tip black marker.

18.6.4. All conduit identifications shall be those taken from the Conduit Schedule which is attached to these Specifications.

18.7. LABELING OF CABLE

The Contractor shall provide and install labels on all newly-installed cables as a part of this work. This shall require that the Contractor perform each of the following:

18.7.1. All cables are to be labeled:

A. At both ends.

B. Where entering and leaving the cable trench.

C. Where exiting station electrical equipment, to include all AC/DC power panels, power circuit breakers, power transformers, junction boxes, fiber optic, video, and station control panels, etc.

18.7.2. Cable identification tags will be attached to the cable in a manner approved by the Project Representative. The Contractor shall prevent galvanic corrosion and not intermix dissimilar metals (Aluminum-Copper, Stainless Steel-Aluminum) when attaching tags to cables. Plastic cable ties shall not be permitted for exterior applications. Examples of exterior connection methods are lockable beaded chain and metal wire.

18.7.3. Outdoor cable identification tags shall be 1/2" wide stainless steel, Dymo M1011 system, unless otherwise approved by the Project Representative. Indoor cable identification tags shall be RhinoPRO 1/2" flexible nylon labels - black on white, Manufacturer part# 18488, unless otherwise approved by the Project Representative. Indoor labels shall be secured with no less than two plastic cable ties.

18.7.4. All cable identification tags will have the appropriate cable number clearly stamped in no less than 1/4" high characters. Cable numbers are specified on the Cable Schedule attached to these Specifications.

19. SUBSTATION SIGNAGE

The Contractor shall install the following signage on the substation fence, wall, or partitions, and control house entry point(s) as a part of this Work. The signage shall consist of four (4) components, the signs which shall be used on the Perimeter Security Boundary (which shall normally be a fence or a wall), the Perimeter Entry Points (gates, doors, etc.), the Control House Entry Points (typically doors) and inside substation perimeter road (near live equipment, bus, switches etc.).

19.1. Perimeter Signage: The perimeter signage shall consist of signs labeled "WARNING HAZARDOUS VOLTAGE KEEP OUT", placed at approximately Forty (40') foot spacing around the entire perimeter boundary (fence, wall, etc.) and at a conspicuous height, approximately Six (6') feet.

19.1.1. "Warning Hazardous Voltage Keep Out" (JEA Item ID# sigda010),

19.2. Substation Entry Points Signage: Each entryway shall have signage in addition to the requirements of the perimeter signage. Entryways include the fence gates and wall entryways. The entryways shall each have the following four (4) signs:

19.2.1. "WARNING HAZARDOUS VOLTAGE KEEP OUT" (JEA Item ID# SIGDA003)

19.2.2. "SAFETY INSTRUCTIONS / PPE" (JEA Item ID# SIGDA004)

19.2.3. "NOTICE CONTACT SYSTEM DISPATCH BEFORE ENTERING/AFTER SECURING" (JEA Item ID# SIGDA005)

19.2.4. "NOTICE PRIVATE PROPERTY NO TRESPASSING" (JEA ITEM ID# SIGDA012)

19.3. Control House Entry Point Signage: Each Control House Entry Point (door, roll up doors, or any other appurtenance for the admission of persons under reasonable conditions) shall have signage in addition to the requirements mentioned above. For this paragraph, the "Control House" shall be any and every humanly-accessible building within or adjoining to the substation property that contains any electrical apparatus that monitors, controls, or otherwise is essential to the operation of the substation, and is not otherwise designed for novice/public entry and occupancy. Each Control House Entry Point shall each have the following sign:

19.3.1. "NOTICE CONTACT SYSTEM DISPATCH BEFORE ENTERING/AFTER SECURING" (JEA Item ID# SIGDA005)

19.4. Interior Substation Signage: Danger signs to be placed inside substation (at inner perimeter of road, by side of switchgear, near transformers, breakers, capacitor banks, bus, and feeders. The following sign and fiberglass post shall be used:

19.4.1. DANGER HAZARDOUS VOLTAGE KEEP OUT (JEA Item ID# SIGDA011)

19.4.2. FIBERGLASS POST (JEA Item ID# SIGPO014)

19.5. Exact location of the signage may be reviewed and modified with the concurrence of the on-site Project Representative.

19.6. All signs for this Work shall be provided by JEA. The Contractor shall request the signage indicating type and quantity, in writing (by email or other typewritten instrument) from the Project Representative approximately two (2) weeks in advance of need.

19.7. The Contractor may assume that all signs for this Work shall include corner holes riveted with a non-corroding grommet or eyelet. The Contractor shall fasten the signs to the perimeter fence or wall, or control house door, in a manner that is to be submitted in writing (by email or other typewritten instrument) to, and approved by, the Project Representative.

SPECIFICATION FOR SURFACE PREPARATION OF ALUMINUM JOINTS

ON EACH ORDER IT WILL HAVE TO BE DETERMINED BY CHECKING DRAWINGS, THE TYPE OF CONNECTIONS REQUIRED.

THE PROCEDURE TO BE FOLLOWED WILL FALL UNDER ONE OR MORE OF THE FOLLOWING SECTIONS:

A. LAP JOINING OF ALUMINUM.
B. LAP JOINING OF ALUMINUM AND COPPER.
C. CONNECTING ALUMINUM LINES TO ALUMINUM BUS.
D. CONNECTING FUSES TO ALUMINUM BUS.

A. LAP JOINING OF ALUMINUM.

1. IF CONTACT SURFACES ARE NOT ABSOLUTELY FLAT, GRIND THEM SO THEY DO PRESENT FLAT SURFACES.

2. THOROUGHLY REMOVE ANY GREASE OR DIRT FROM CONTACTING SURFACES. COAT THE CONTACT AREAS WITH A MINIMUM OF 1/16" THICK COATING OF A GRITLESS CORROSION INHIBITOR AND STEEL BRUSH CONTACT SURFACES THOROUGHLY, THROUGH THE COMPOUND, TO REMOVE ALL THE ALUMINUM OXIDE. DO NOT ALLOW THE SURFACE TO BECOME BARE AT ANY POINT AS THE COATING SHOULD COVER THE CONTACT SURFACE AT ALL TIMES.

3. ASSEMBLE THE JOINT USING A MINIMUM OF TWO 1/2" BOLTS WITH A LARGE FLAT WASHER UNDER THE HEAD AND ANOTHER LARGE FLAT WASHER BETWEEN THE ALUMINUM BUS AND SPLIT LOCKWASHER.

ALL BOLTED CONNECTIONS TO BE TORQUED TO REQUIREMENTS IN SPEC. GA3B. EXCESS COATING MATERIAL TO BE WIPED OFF SO AS TO FILL IN ALL VOIDS AROUND THE EDGES OF THE JOINT AND GENEROUSLY FILLET THE INSIDE CORNER OF JUNCTION. BUS JUNCTIONS ON UNITS THAT WILL BE EXPOSED TO EXTREME CORROSIVE CONDITIONS SHOULD HAVE THE ENTIRE BOLTED JUNCTION COATED WITH A LAYER OF COMPOUND TO A DEPTH OF 1/16"MINIMUM.

B. LAP JOINING OF ALUMINUM AND COPPER.

1. ALUMINUM CONTACTING SURFACE TO BE THOROUGHLY CLEANED OF ANY GREASE OR DIRT. COAT THE CONTACT AREA WITH A MINIMUM OF 1/16" THICK COATING OF A GRITLESS CORROSION INHIBITOR AND STEEL BRUSH CONTACT SURFACE THOROUGHLY, THROUGH THE COMPOUND, TO REMOVE ALL ALUMINUM OXIDE.

2. THE SURFACE OF THE COPPER CONNECTOR WHICH IS IN CONTACT WITH THE ALUMINUM TO BE BARE OF ANY TINNING OR PLATING BUT MUST BE THOROUGHLY CLEANED OF ANY GREASE OR DIRT. COPPER CONNECTORS WITH TONGUES ARE TO BE ASSEMBLED TO ALUMINUM BUS WITH 1/2" BOLTS WITH 1/2" LARGE FLAT WASHER BETWEEN ALUMINUM BUS AND SPLIT LOCKWASHER. BOLTS MUST BE TORQUED TO REQUIRMENTS IN SPEC. GA3B. BUS JUNCTIONS ON UNITS THAT WILL BE EXPOSED TO EXTREME CORROSIVE CONDITIONS ARE TO HAVE THE COPPER SURFACE IN THE VICINITY OF THE ALUMINUM BUS COATED WITH COMPOUND. THE COATING TO BE MINIMUM OF 1/16" THICK WITH ALL VOIDS FILLED AND INSIDE CORNERS FILLETED WITH COMPOUND.

3. WHEREVER POSSIBLE, THE CONNECTION OF ALUMINUM TO COPPER SHOULD BE ARRANGED WITH THE ALUMINUM ON TOP AND AT THE HIGHER LEVEL SO THAT THE WATER COLLECTING ON THE CONDUCTOR AND ON THE JOINT, WILL RUN TOWARD THE COPPER CONDUCTOR.

C. CONNECTING ALUMINUM LINES TO ALUMINUM BUS.

1. ALUMINUM FITTINGS MUST BE USED WHEN INCOMING LINES ARE ALUMINUM.

2. CONTACT SURFACES MUST BE FLAT. THOROUGHLY REMOVE ANY GREASE OR DIRT FROM CONTACT SURFACES. COAT THE CONTACT AREAS OF BOTH BUS AND LINE WITH A MINIMUM OF 1/16" OF A GRITLESS CORROSION INHIBITOR AND BRUSH CONTACT SURFACES THROUGH COATING WITH A STIFF STEEL WIRE BRUSH. DO NOT ALLOW THE SURFACE TO BECOME BARE AT ANY POINT AS COATING SHOULD COVER THE CONTACT SURFACE AT ALL TIMES.

3. ASSEMBLE THE JOINT USING 1/2" BOLTS WITH A LARGE FLAT WASHER UNDER THE HEAD AND ANOTHER LARGE FLAT WASHER BETWEEN ALUMINUM BUS AND SPLIT LOCKWASHER. BOLTED CONNECTIONS TO BE TORQUED TO REQUIRMENTS IN SPEC. GA3B. EXCESS COATING MATERIAL TO BE WIPED OFF SO AS TO FILL ALL VOIDS AROUND EDGES OF JOINT AND FILLET ALL INSIDE CORNERS OF JUNCTIONS.

D. CONNECTING FUSES TO ALUMINUM BUS.

THE CONTACT CAP FOR CAPACITOR FUSE IS ALUMINUM. THE SURFACE OF ALUMINUM BUS COMING IN CONTACT WITH CONTACT CAP MUST FIRST BE CLEANED OF ALL GREASE, AND THEN COVERED WITH A GRITLESS CORROSION INHIBITOR TO A DEPTH OF A MINIMUM OF 1/16" AND BRUSHED WITH A STIFF STEEL WIRE BRUSH. THE SURFACE SHOULD NOT BE ALLOWED TO BECOME BARE. THE CONTACT CAP TO BE BOLTED TO ALUMINUM BUS WITH A 5/16" STAINLESS STEEL BOLT WITH A LARGE FLAT STAINLESS STEEL WASHER AND A STAINLESS STEEL SPLIT LOCKWASHER UNDER THE HEAD OF BOLT. CORROSION INHIBITOR TO BE ADDED AS NECESSARY TO OBTAIN A GENEROUS FILLET AT THE INSIDE CORNER JUNCTION.

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05	07-12-05	JKG	05-0838
04	02-28-96	JKM	96175
03	08-25-78	TAW	78-541

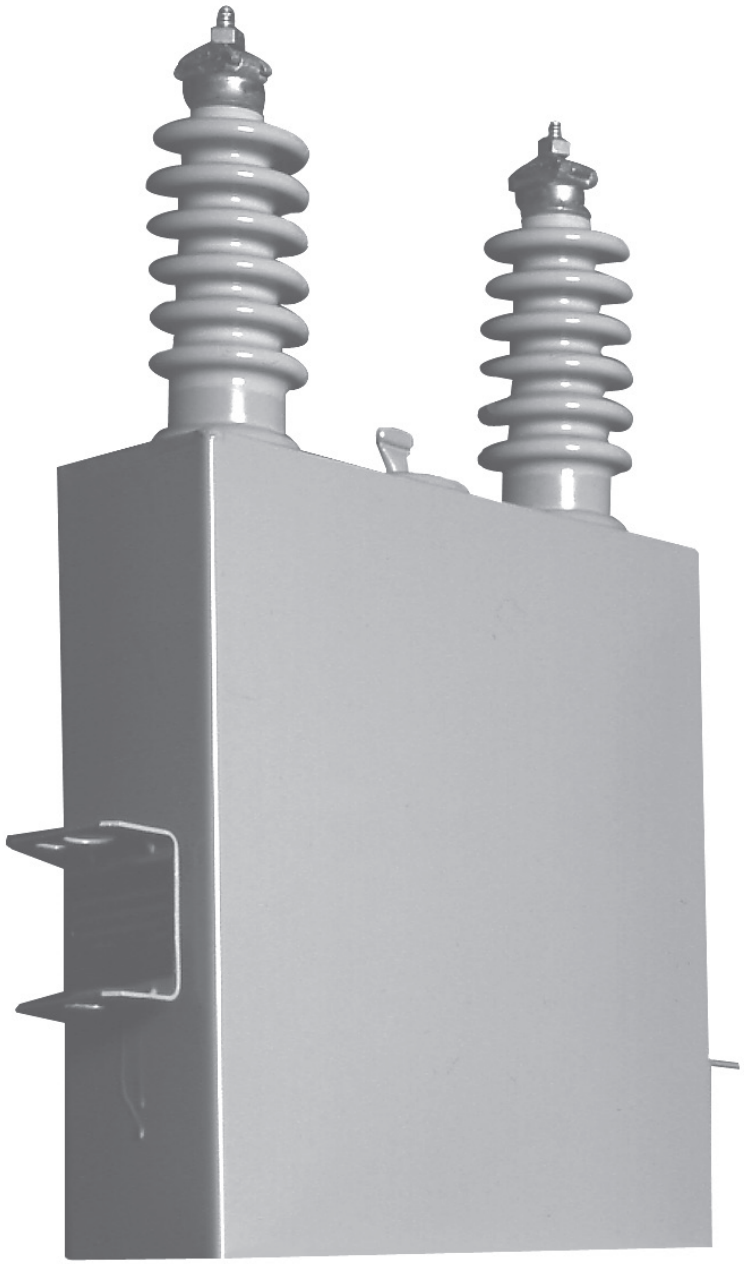
COOPER

SPECIFICATION FOR SURFACE PREPARATION OF ALUMINUM

DR. TW | DATE 08-25-78
CH.
AP. | SH__OF__

CCZ002B

Medium-voltage, single-phase capacitor installation and maintenance instructions



Powering Business Worldwide

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Contents

Safety for life

Eaton's Cooper Power series products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high-voltage lines and equipment and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians, who are familiar with this equipment should install, operate and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

CAUTION

Indicates a hazardous situation which, if not avoided, could result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.3

⚠ IMPORTANT

This instruction literature applies to both internally-fused capacitors and unfused capacitors. An unfused capacitor unit does not have internal fuses. An internally-fused capacitor unit includes internal fuses for each element.

Product information

Introduction

Service Information MN230002EN covers instruction for installing and maintaining the Eaton's Cooper Power series line of medium-voltage, single-phase capacitors (Figure 1). Where applicable, the requirements of federal, state, local codes and insurance underwriters must be fulfilled.

Read this manual first

Read and understand the contents of this manual and follow all locally approved procedures and safety practices before installing or operating this equipment.

Additional information

These instructions cannot cover all details or variations in the equipment, procedures, or processes described nor provide directions for meeting every possible contingency during installation, operation, or maintenance. For additional information, contact your Eaton's Cooper Power series product representative.

Handling and storage

Be careful during handling and storage of the capacitor to minimize the possibility of damage. If the capacitor is to be stored for any length of time prior to installation, provide a clean, dry storage area.

⚠ CAUTION

Eaton's Cooper Power series power capacitors are housed in hermetically sealed tanks that contain all-film solid dielectric packs impregnated with a non-PCB fluid dielectric. Do not drop, jar, or otherwise handle a capacitor in a manner that would violate the integrity of the hermetic seal.

Standards

ISO 9001 Certified Quality Management System

Initial inspection

Immediately upon receipt of a capacitor shipment:

1. Check each capacitor nameplate to make sure the voltage rating is correct for the system on which the capacitor is to be applied.
   A. Power capacitors must be connected only to systems on which the terminal-to-terminal voltage does not exceed rated voltage shown on each capacitor nameplate.

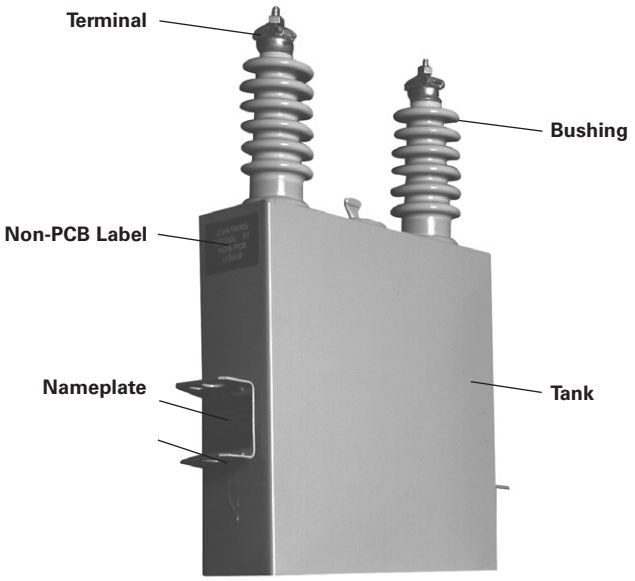

Figure 1. Medium-voltage, single-phase power capacitor

   B. Capacitors to be connected in delta must be rated at the line-to-line system voltage.
   C. Capacitors to be connected in wye must be rated at the line-to-neutral system voltage.
2. Check each capacitor tank and bushing for signs of rough handling or damage in transit.
   - If a capacitor bushing is damaged or a capacitor tank has dents, bulges, and/or leaks, set the capacitor aside and file a claim with the carrier and notify your Eaton's Cooper Power series product representative.

⚠ CAUTION

Operation at an ambient temperature higher than 55 °C (131 °F) will shorten the service life of a power capacitor.

Pre-installation preparations

1. Make sure that branch circuit conductors have a current-carrying capacity at least 135% of the operating current of the capacitor installation.
2. Make sure the ambient temperatures in which the capacitor installation is to operate is between –50 °C and 55 °C (–58 °F and 131 °F).
3. Make sure the capacitor installation is protected by a correctly rated fuse. (Contact your local Eaton's Cooper Power series product representative for fusing application guidelines.)

Installation

1. De-energize the circuit.
2. Install the rack or frame in which the capacitors are to be mounted.
3. Hoist each capacitor into position in the rack or frame using the capacitor's hanger brackets.

⚠ CAUTION

Never use a bushing as a handle when lifting or moving a power capacitor; use only the hanger brackets.

Never use the hanger brackets of the capacitor when lifting a complete capacitor installation. Never walk on an installed capacitor unit or its bushing(s).

4. Install each capacitor in the rack or frame so that heat from other equipment is minimal and air can circulate freely around each capacitor in the installation.
   - The capacitor terminals accept single-conductor sizes from no. 12 to no. 1 solid or stranded or two-conductor sizes from no. 8 to no. 2 stranded.

⚠ CAUTION

It is important to use a properly sized conductor with the connector to assure good electrical contact without arcing.

   - The recommended torque on a terminal clamp nut is 16–19 ft-lb. (21.7 to 25.8 N-m)
5. If switches are to be installed, hoist them into position on the rack or frame.
6. Ground the mounting frame and ground each capacitor tank to the frame or to the ground.
7. If shorting wires were used for storage/transportation of the capacitor unit, verify that they are removed prior to energization.
8. Make all electrical connections.
9. Re-energize the circuit.

Maintenance

Periodic inspections and maintenance are recommended to check capacitance, bushing contamination, or fuse operations.

1. De-energize the capacitors.
2. Clean all bushings.
3. Make sure all electrical connections are tight.
4. Inspect all capacitor tanks for leaks.

⚠ WARNING/DANGER

Do not re-energize a capacitor that has experienced a fuse operation without first making sure that the capacitor has not failed. All-film capacitors may fail without being severely bulged and may rupture on re-energization.

Checking the capacitance of a capacitor is the best way to determine if the capacitor is sound or has completely or partially failed.

5. If applicable, Inspect all fuse cutouts, and if a fuse cutout has operated—or if the capacitors have been subjected to unusual operating conditions—use a low-voltage capacitance meter to check the condition of all capacitors.

Note: Shorting one internal series group in an unfused capacitor results in a predictable increase in the capacitance level. Shorting an internal element (with a corresponding fuse operation) in an internally-fused capacitor results in a reduction in the capacitance level. See Handling a Partially-failed Capacitor Unit section below for the formula to verify if internal elements within the capacitor have failed.

Note: Not applicable to internally fused capacitors.

⚠ WARNING/DANGER

Proper skin, eye, and respiratory protection must be worn and the work area must be properly ventilated when handling a ruptured (failed) capacitor tank. Be extremely careful in removing a ruptured tank from a frame or rack and while transporting the tank to a disposal site.

If fluid dielectric spills or splashes onto the skin, immediately wipe the liquid from the skin, then wash the affected skin area thoroughly with soap and water.

If fluid dielectric splashes into the eyes, immediately flush the eyes with large amounts of clear water. Call a physician immediately.

If fluid dielectric is ingested, administer 2 to 4 oz. of vegetable or olive oil and 1 to 2 oz. of activated charcoal. DO NOT INDUCE VOMITING. Call a physician immediately.

Handling a failed capacitor

1. Ensure power is removed from the capacitor.
2. Allow the capacitor to discharge before shorting. For units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 50 V in 5 minutes, allow five minutes before grounding. For units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 75 V in 10 minutes, allow ten minutes before grounding. In the absence of design information, wait ten minutes before grounding.
3. Remove the capacitor from the frame or rack.

Handling a partially-failed capacitor unit

Use the following formula for detecting partially failed **unfused** capacitor unit:

1. Measure capacitance of the unit with a capacitance meter. This is the $C_{measured}$ value.
2. If $C_{measured} > C_{rated}\left[\frac{S}{S-1}\right]$, then the capacitor is partially-failed and should be removed from the circuit, where S is the number of series groups inside a single capacitor.

Use the following formula for detecting partially failed **internally-fused** capacitor unit:

1. Measure capacitance of the unit with a capacitance meter. This is the $C_{measured}$ value.
2. If $C_{measured} < C_{rated}\left[\frac{S \times (P-F)}{(S-1) \times (P-F)+P}\right]$, then the capacitor is partially failed and should be removed from the circuit, where S is the number of series groups inside a single capacitor, P is the number of parallel elements, and F is the number of operated internal fuses. (Internally-fused units can have one or more operated internal element fuses and not change the measured capacitance beyond the tolerance allowed for the rated capacitance by the standards.)

Disposal of capacitors

The impregnating fluid dielectric in Eaton's Cooper Power series power capacitors is a non-PCB biodegradable, Class IIIB, combustible liquid. Disposal of these capacitors by incineration or other means must be in accordance with all applicable federal, state, and local regulations.

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Externally fused block banks installation instructions

Powering Business Worldwide

DISCLAIMER OF WARRANTIES AND LIMITATION OF LIABILITY

The information, recommendations, descriptions and safety notations in this document are based on Eaton Corporation's ("Eaton") experience and judgment and may not cover all contingencies. If further information is required, an Eaton sales office should be consulted. Sale of the product shown in this literature is subject to the terms and conditions outlined in appropriate Eaton selling policies or other contractual agreement between Eaton and the purchaser.

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Contents

Safety for life

Eaton meets or exceeds all applicable industry standards relating to product safety in its Cooper Power™ series products. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing, and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high-voltage lines and equipment, and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians who are familiar with this equipment should install, operate, and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as arc flash clothing, safety glasses, face shield, hard hat, rubber gloves, clampstick, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

DANGER

Hazardous voltage. Contact with hazardous voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment. G103.3

WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage. G101.0

WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply can result in death, severe personal injury and equipment damage. G102.1

WARNING

Power distribution and transmission equipment must be properly selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain power distribution and transmission equipment can result in death, severe personal injury, and equipment damage. G122.3

These instructions do not claim to cover all details or variations in the equipment, procedure, or process described, nor to provide directions for meeting every possible contingency during installation, operation, or maintenance. When additional information is desired to satisfy a problem not covered sufficiently for the users purpose, please contact your Eaton's Cooper Power series product representative.

Safety precautions

1. Lift all blocks with the supplied lifting lugs. Lift all other parts by structural members only in accordance with their respective instructions, if applicable. Do not lift any equipment by the bushings or insulators unless directed by its instructions, if applicable.
2. DO NOT climb on insulators, bushings or capacitor units.
3. DO NOT ground a capacitor bank immediately after the bank has been disconnected from the system. For capacitor banks with units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 50 V in 5 minutes, allow five minutes before grounding. For capacitor banks with units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 75 V in 10 minutes, allow ten minutes before grounding. In the absence of design information, wait ten minutes before grounding.
4. Ground all parts after de-energization and before touching frames or terminals. Ground the neutral of ungrounded capacitor banks.

Figure 1. Externally fused capacitor bank

5. Before handling, short-circuit the terminals of all capacitor units.
6. For capacitor banks with units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 50 V in five (5) minutes, wait at least five (5) minutes before re-energizing the bank after it has been disconnected from the system. For capacitor banks with units containing discharge resistors designed to discharge the capacitor unit from peak rated voltage to less than 75 V in ten (10) minutes, wait at least ten (10) minutes before re-energizing the bank after it has been disconnected from the system. These times may be reduced with consultation of the factory.
7. DO NOT re-fuse and energize a capacitor unit which has a brown fuse without first checking the capacitane of the capacitor unit to ensure it is within it's acceptable tolerance. **Energizing shorted or partially shorted capacitor units may produce unexpected results including catastrophic failure of the capacitor unit and associated equipment.**
8. DO NOT energize a capacitor unit that has been shorted terminal-to-terminal or that has a bulged or otherwise damaged tank. See **Recommended Refusing Procedures.**
9. Use all precautions for capacitor equipment in the same manner as listed under the utilities' regulations for high-tension equipment.
10. The tank of the capacitor units provides a hermetic seal for the internal elements and dielectric fluid. DO NOT drop, jar, or otherwise handle a capacitor in a manner that would violate the integrity of the hermetic seal. DO NOT lift capacitor units by the bushings. Use only the hangar brackets.

See Service Information MN230002EN High-Voltage, Single-Phase Installation and Maintenance Instructions for guidance on the proper handling of individual capacitor units.

Warranty

The performance of Eaton's Cooper Power series externally fused block banks is warranted for a period of one year from the date of shipment. Eaton will, at its option, correct, by repair or replacement, capacitor blocks or components which may fail because of defects in material or workmanship. The warranty is valid only if the equipment has been inspected completely upon receipt, installed properly, and has not been subjected to abnormal conditions. Such corrections shall constitute a fulfillment of all liabilities of Eaton. The company will not be liable for consequential damages or any expenses incurred in installation or transportation.

The proliferation of nonlinear loads in power systems has given rise to potential harmonic distortion problems when applying capacitors. When applying capacitor banks, a system study is recommended to determine if there will be any resonance between the capacitors and the system that may accentuate existing harmonics. Eaton can perform these studies.

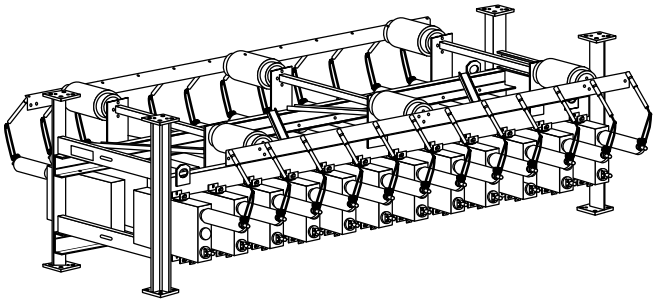

Figure 2. Externally fused capacitor block

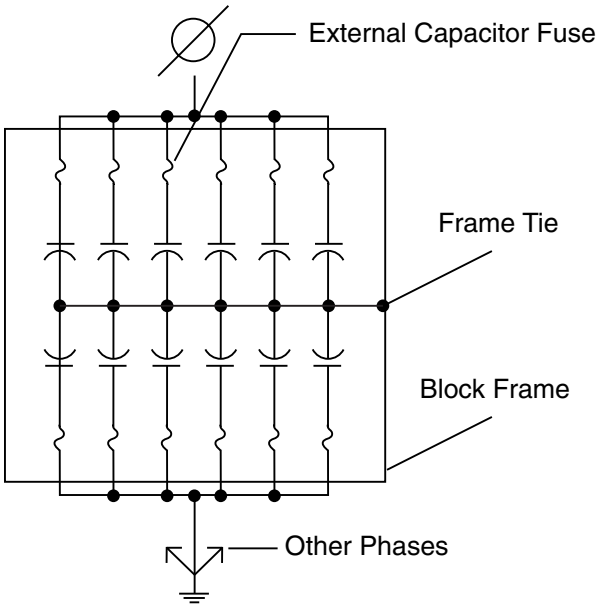

Figure 3. Typical externally fused capacitor bank schematic (One phase)

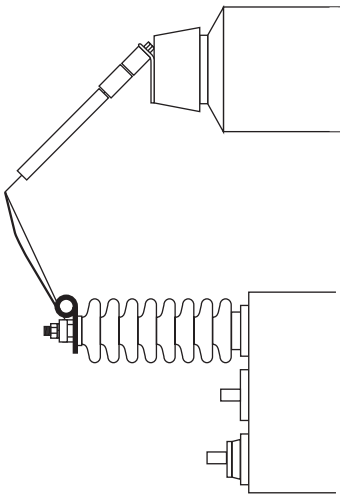

Figure 4. External expulsion fuse

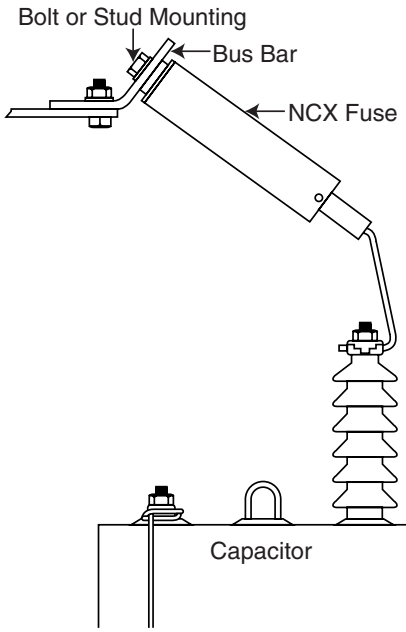

Figure 5. External current limiting fuse

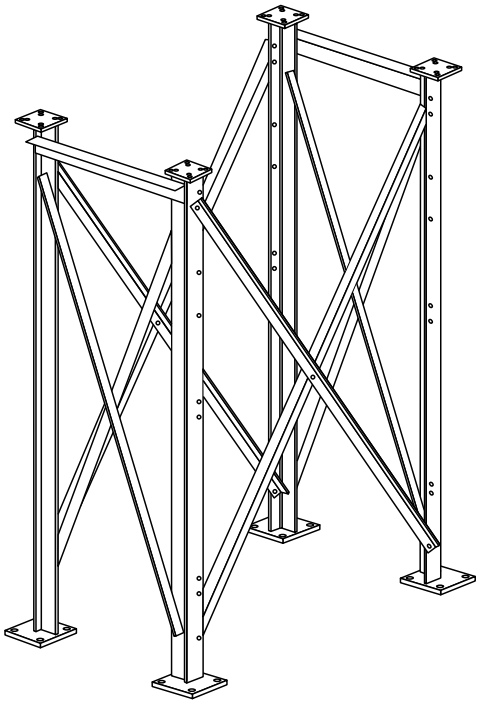

Figure 6. Typical elevating structure

Any other unusual/abnormal service conditions such as those listed in the Unusual Service Conditions section of these instructions, should be brought to the attention of Eaton. Modifications to the bank may require revision of the quoted price.

Shipment

Externally fused capacitor blocks and their associated equipment are shipped on pallets, in open or closed crates or in containers.

Instruction manual

Instruction manuals will be forwarded to you prior to the shipment of the equipment and a copy will be enclosed with the shipment. Thoroughly read and understand the instruction manual prior to movement, installation, operation and maintenance of the capacitor bank. The instruction manual will contain the following at a minimum:

- Final drawings
- Bills of materials
- Torque requirements
- These instructions
- Drawings and instructions for other equipment supplied (as available).

Receipt inspection

Upon receipt, carefully inspect all equipment for damage or loss. If any discrepancies are revealed, immediately file a claim against the transportation agency and notify Eaton.

Use the factory bills of material and construction drawings to verify receipt of all equipment. The inspection should include the following items:

- Inspect all insulators and bushings for cracks.
- Verify all nameplate data to ensure the equipment is as ordered.

Storage instructions

Unless the capacitor equipment is to be installed immediately, store to minimize the possibility of mechanical and weather damage. In particular, protect the capacitor bushings, all porcelain, electronic gear and other fragile items against mechanical damage.

Capacitor equipment for indoor installation must be stored indoors. Capacitor equipment for outdoor installation may contain items such as electronic relays that should not be stored outdoors. After receipt inspection, store all such items indoors.

Externally fused capacitor banks

Each phase of an externally fused capacitor bank is constructed of one or more series groups of parallel connected capacitor units. Each capacitor unit is protected with either a current limiting or an expulsion fuse external to the unit. Figure 3 is a schematic of one phase of a typical externally fused capacitor bank composed of two series groups of six parallel connected capacitor units. Each phase is contained in one block.

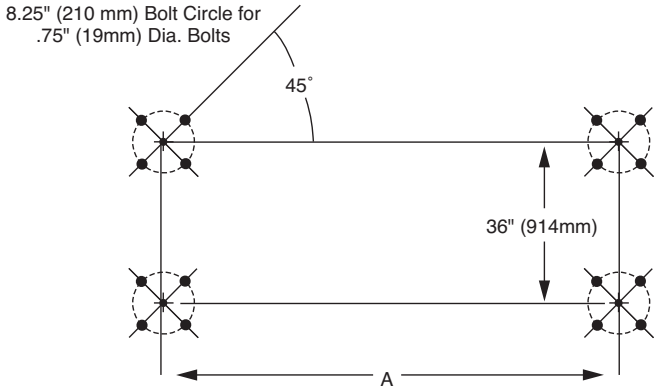

Figure 7. Typical anchor bolt plan

Equipment description

Externally fused capacitor blocks are suitable for indoor or outdoor installation. The bank will consist of one or more blocks of capacitors. The block frames and other structure may be constructed of marine grade structural aluminum or galvanized steel.

Installation

Externally fused capacitor banks may be suitable for both indoor and outdoor installation depending on the accessories. The blocks can be mounted on platforms, elevating structures, Figure 6, or directly to the foundation. The stacking of the externally fused capacitor blocks may require base and/or stacking insulators. Base insulators isolate the blocks from the platform, elevating structure or foundation. Stacking insulators are used to provide electrical insulation between block frames at different potentials. When base insulators will be directly mounted to a concrete foundation, adapters may be required.

Anchor bolt plans, Figure 7, and static foundation loading are furnished with the capacitor bank assembly drawings. The design of all concrete footings and foundations are dependent on the soil conditions at the installation site and are thus the responsibility of the customer. Anchor bolts are selected and furnished by the customer.

Field assembly drawings

Field assembly drawings are supplied with the instruction manual. Prior to installation, study the assembly drawings to develop a plan for assembly.

Moving capacitor equipment

When the capacitor block is to be moved, it must be lifted using the lifting lugs provided. The lifting lugs are designed to support the weight of only one block. Do not lift multiple blocks simultaneously. Using lifting points other than those provided may result in damage to the block frame and/or the installed capacitor units. Do not attempt to slide or skid the block. Lifting speed must be smooth and constant to avoid impulse loading.

Lift all other parts by structural members only in accordance with their respective instructions, if applicable. Do not lift any equipment by the bushings or insulators unless directed by its instructions, if applicable.

Erection of elevating structure

An elevating structure, Figure 6, may be supplied to raise the capacitor equipment above the foundation for equipment protection and personnel safety. The bottom plates of the elevating structure have holes for anchoring to the foundation. The top plates have holes for the mounting of a capacitor block or station post insulators.

The elevating structure is shipped unassembled from the factory. Components include two welded end sections, two sets of cross braces and the necessary hardware. The bottom plates are coated with asphalt paint. To assemble:

1. Set the two welded end sections over the anchor bolts in the foundation and secure with lock washers and nuts.
2. Tie the cross braces with two nuts and bolts at each end section and one nut and bolt in the middle at the point of brace cross-over. A spacer is used at the point of brace cross-over for proper geometry.

Framework for the support of equipment such as switches, arresters, reactors, insulators and conductors may be supplied for attachment to the elevating structure.

Position of blocks

Care must be taken to place the blocks in the bank in accordance with the outline drawings. The nameplates of each block must all be on the same end for correct operation.

Fuse installation and connections

Banks with capacitor units protected with bus-mounted expulsion fuses, Figure 4, are shipped with the fuses installed but not connected to the terminals of the capacitor unit to prevent damage during shipment. See Service Information MN230005EN Expulsion Fuse Installation Instructions for detailed installation instructions.

If the capacitor units are protected with current limiting fuses, the fuses are shipped separately from the block. See the bank instruction manual for drawings showing the current limiting fuse correctly installed in the bank. Use the following instructions for installing Eaton's Cooper Power series NXC® bus-mounted capacitor fuses (Figure 5):

1. Prepare the surface of the bus bar and the fuse to make the electrical connection.
2. Bolt the fuse to the bus bar utilizing the hardware provided using a torque of 30 ft-lb (40.7 N-m).
3. Straighten the fuse lead wire such that there are no entanglements.
4. A parallel groove clamp with two belleville washers is included on each terminal of each capacitor unit. Route the end of the lead wire through both sides of the parallel groove connector on the appropriate terminal. The lead wire should be snug and not contain any slack. Tighten the nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).
5. Trim the excess lead wire. Approximately 3/8 inch (10 mm) of lead wire should extend beyond the clamp assembly.

Use the following instructions for installing Eaton's Cooper Power series Combined Technologies X-Limiter busmounted fuses:

1. Prepare the surface of the bus bar and the fuse to make the electrical connection.
2. Bolt the fuse to the bus bar utilizing the hardware provided using a torque of 30 ft-lb (40.7 N-m).
3. Parallel groove clamps, hardware and wire are supplied for attaching a fuse lead wire to the fuse. Assemble a parallel groove clamp to each fuse with the hardware as shown in the drawing included in the instruction manual. Route a length of wire through both sides of the parallel groove connector on the fuse to make a fuse lead wire. Tighten the nut using a torque of 30 ft-lb (40.7 N-m).
4. Straighten the fuse lead wire such that there are no entanglements.
5. A parallel groove clamp with two belleville washers is included on each terminal of each capacitor unit. Route the end of the lead wire through both sides of the parallel groove connector on the appropriate terminal. The lead wire should be snug and not contain any slack. Tighten the nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).
6. Trim the excess lead wire. Approximately 3/8 inch (10 mm) of lead wire should extend beyond the clamp assemblies.

Bank erection

If used, the base and stacking insulators should be bolted in place with their hardware loose for adjustment. Slowly lower the block to its mounting position avoiding impact. Use flat and lock washers on all bolts used to assemble the blocks to each other or their base.

Electrical connections

The conductor used to connect the capacitor bank to the system should have a continuous current rating of at least 35 percent more than the nominal current rating of the bank.

The assembly of all electrical connections is of vital importance to the proper operation of the capacitor bank. All connections should be made in accordance with the instruction manual. It is highly recommended that the torque of all electrical connections be checked at least 24 hours after the initial torque. This allows for some plastic deformation of the metal of the base conductor, connectors and hardware.

Grounding

If supplied, one leg of each elevating structure end section is supplied with a two-hole NEMA pad. Connect a suitable size conductor from the two-hole NEMA pad to the ground. Base adapters should be grounded with a conductor attached between the anchor bolt nut and the adapter.

Series reactors

Series reactors may be supplied for current-limiting and/or tuning of the bank. Reactors connected in series with the capacitor bank should have a continuous current rating of at least 35 percent more than the nominal current rating of the bank. This requirement may be relaxed for highly tuned capacitor/reactor combinations where the currents are more predictable.

When applying a series reactor, care must be taken to ensure proper clearance between the reactor and metallic objects and sensitive electronic equipment. If the reactor is supplied with the capacitor bank, the outline drawing will have the reactors placed for proper clearance with all other equipment in the drawing. Consult the reactor drawings in the instruction manual for the required clearance to other equipment.

Surge arresters

It is recommended that capacitor banks be protected against overvoltages due to lightning or switching surges with surge arresters. To protect the capacitor bank from the high overvoltages associated with a switch restrike, the arresters should be applied between the switching device and the capacitor bank and as close to the capacitor bank as possible.

Care must be taken to ensure that the energy rating of the arresters is adequate for application at a capacitor bank. For switched capacitor banks, the highest energy condition arresters are likely to see is the restrike of the capacitor bank switch when de-energizing the bank. It is recommended to size the arresters for the energy associated with a single restrike of the switch.

Capacitor switching

Capacitive currents

The capacitor bank switching device should have a continuous current rating of at least 35 percent more than the nominal current rating of the bank. The switching device should be capable of energizing and de-energizing the bank at maximum system voltage, with the maximum harmonic distortion of the bank current and with the bank neutral grounded or ungrounded as applicable.

Grounded wye capacitor banks subject the capacitor bank switching device to a 2 per unit recovery voltage. Ungrounded wye capacitor banks subject the capacitor bank switching device to recovery voltages higher than 2 per unit and as high as 4.1 per unit. The voltage rise across series connected tuning reactors result in higher recovery voltages than encountered when switching banks without series connected reactors.

Capacitor switching devices not rated for capacitor switching may restrike resulting in high system voltage surges that can damage the capacitor bank, arresters and other equipment.

Inrush and outrush currents

When the capacitor bank switch is closed, a high-frequency, high-magnitude current flows into the bank attempting to equalize the system and capacitor voltages. If the bank is isolated from other banks, the inrush current is limited by the impedance of the source and the bank. Typical values for this inrush current are 5 to 20 times the nominal bank current at frequencies of several hundreds of hertz.

If two or more capacitor banks are connected on the same bus, very high magnitude and frequency currents are possible during switching. Only the impedance of the banks and circuit limit the current. Care should be taken when applying capacitor banks of differing sizes or more than two banks back-to-back as the resulting transient currents due to switching may apply an I^2t duty to the individual fuses beyond their withstand. In extreme cases, resistance may need to be added in the back-toback circuit to protect the fusing.

Current outrush from a capacitor bank may also be a concern if a fault develops or a breaker closes into a fault.

Equipment such as the unbalance relaying equipment, capacitor bank switching device and other switching devices in the substation may not withstand these transient currents. It is recommended that the factory be consulted when the banks will be switched back-to-back or anytime there is doubt regarding the magnitude and frequency of the currents, or the suitability of the installation.

Protective relaying

The purpose of capacitor bank protective relaying is to increase the availability of the capacitor bank by warning personnel of problems in the bank and removing the bank from service before severe damage occurs. The design of the protective relaying begins with bank design.

Unbalance relaying

Unbalance protection should be applied. In practice, the unbalance is comprised of the following types:

- Inherent Unbalance
- System Unbalance
- Unbalance due to fuse operations

The inherent unbalance is that due to the manufacturing tolerances of the capacitor units. The system unbalance is that due to system phase voltage unbalance.

The sensitivity necessary to detect individual fuse operations is dependent on the size and connection of the bank. Large single wye connected banks may require an unbalance detection scheme that is not sensitive to system unbalance and can be adjusted to compensate for the capacitor bank inherent unbalance. Unbalance detection schemes supplied by Eaton are properly designed to provide adequate unbalance protection.

Overcurrent protection

Power fuses or switches with protective relaying should be applied for protection against major faults within the capacitor bank. If switches with protective relaying are supplied with the capacitor bank, the instruction manual will contain information for the setting of the relay.

Initial inspection and testing

The entire bank should be carefully inspected prior to initial energization. Included in the initial inspection should be a check of the following points:

1. Inspect all electrical connections to see that they are installed in the correct locations and are tight for good contact. Many electrical joints can relax due to material deformation. Eaton recommends to re-torque all electrical joints at least 24 hours after the initial assembly.
2. Verify the mechanical assembly of the bank is in accordance with the outline drawings and is sound.
3. Verify electrical clearances around and within the bank.
4. Verify all shipping bracing is removed.
5. Wipe clean all insulators and bushings. Visually inspect for damage such as chips and cracks. Dirty insulators and bushings may cause flashover and damage to the equipment.
6. Visually inspect all capacitor units for damaged tanks and leaks.
7. Verify settings of all protective relaying and ensure it is activated.
8. Test operate all load-break, disconnect, and grounding switches and secondary accessory equipment.
9. Just prior to energization, open all grounding and shorting switches and ensure all grounding and shorting tackle is removed.

Initial energization

Immediately after initial energization, perform the following:

1. Verify that the voltage rise is as expected and that the bank voltage and currents are within its ratings. The phase currents should be approximately equal and should not exceed nominal by more than approximately 10% at nominal voltage. Harmonic filter bank currents should be measured with instruments capable of detecting individual harmonic currents and the measured data compared with the expected values.
2. Check the level of unbalance at the unbalance detection relay. A small inherent unbalance may be nulled if the relay has such capability. An unbalance alarm or an otherwise high level of unbalance, not attributable to inherent unbalance, likely means that there has been a dielectric failure.
3. Approximately 24 hours after the initial energization, recheck the level of unbalance and remove the bank from service for visual inspection. This inspection should include a check for signs of overheated electrical joints.

Operation

Unusual service conditions

Unusual service conditions may require special construction or operation and should be brought to the attention of the factory. Among such unusual service conditions are:

1. Operation at altitude above 6000 feet (1800 m).
2. Residual voltage at energization greater than 10% of rated voltage.
3. Exposure to damaging fumes or vapors, salt, air, steam, excessive moisture or dripping water.
4. Exposure to explosive dust or gases.
5. Exposure to excessive, abrasive or conductive dust.
6. Exposure to severe weather conditions.
7. Exposure to abnormal vibration, shocks or tilting including earthquakes.
8. Unusual transportation or storage conditions.
9. Installation that prevents adequate ventilation.
10. Operation in ambient temperatures outside (above or below) the rating of the equipment.

11. Voltage stress on the insulation and dielectric outside the continuous and momentary ratings.
12. Operation at frequencies other than the rated frequency.
13. Unusual wave form distortion or harmonics causing excessive kvar loading or voltages.
14. Back-to-back switching.
15. Any other unusual or special operating requirements.

Overvoltage operation

The capacitors are designed for continuous contingency operation at 110% of rated voltage. Operation of the capacitor bank at voltages above 110% of rated voltage for extended periods of time will shorten the life of the capacitors and should be permitted only in emergency conditions.

These overvoltages are permissible since a safety factor is provided in the design of the capacitors. Consideration should also be given for the possible overvoltage operation due to fuse operations within the bank. The magnitude of overvoltage that can be tolerated without loss of capacitor life is dependent upon the number and duration of the applied overvoltage. The values shown in Table 1 are based on full life expectancy, with overvoltages occurring a maximum of 300 times during the life of the capacitor. For operation at overvoltages beyond those shown in Table 1, consult your Eaton's Cooper Power series product representative.

Table 1. Overvoltage operations

Duration time	Times rated voltages[1]
6 cycles	2.20
15 cycles	2.00
1 second	1.70
15 seconds	1.40
1 minute	1.30
30 minutes	1.25
30 minutes every 24 hours	1.15[2]

1 Multiplying factors apply to rms rated voltage. Crest voltage must not exceed rms by more than $\sqrt{2}$.
2 There is no limit to the number of overvoltages during the life of the capacitor unit.

Undervoltage operation

The bank may be operated at voltages which are less than the capacitor voltage ratings. However, full kvar output varies in direct proportion with the square of the ratio of the applied voltage to the rated voltage.

Inspection and maintenance

Routine maintenance

Eaton's Cooper Power series externally fused capacitor banks require very little maintenance. Periodic maintenance should include the following:

1. Visual examination of the bank looking for foreign matter and damaged or excessively dirty insulators.
2. Visual examination of all capacitor units for damaged or excessively dirty bushings, leakage or unusual swelling.
3. Visual examination of all external fuses for damage.
4. Examination of all electrical connections for signs of overheating.
5. Examine all metal parts for signs of corrosion.
6. Verification of the protective relay settings. At longer maintenance intervals, the protective relaying should be tested.
7. Check the level of unbalance at the unbalance detection relay.

Recommended refusing procedures

Use the following refusing procedure for banks with expulsion fuses:

1. De-energize and isolate the capacitor bank.
2. Ground the incoming phases and neutral after allowing the capacitor bank to discharge. See **SAFETY PRECAUTIONS.**
3. Temporarily short circuit the series group containing the unit with the operated fuse and the capacitor unit itself to ensure the capacitor units are safe to handle.
4. Check the capacitance of the unit with the operated fuse with a capacitance meter to verify that it is within tolerance. The nominal capacitance of a capacitor unit can be calculated with the following formula:

$$C = \frac{Q}{2\pi f V^2} \times 10^9$$

Where: C = Unit Capacitance in microF

Q = Unit nameplate kvar

π = 3.1416

f = Unit nameplate frequency

V = Unit nameplate voltage in volts

The capacitance of a partially failed capacitor unit will be higher than the nominal capacitance. A capacitance higher than 110% of the nominal value usually indicates a shorted internal element. Capacitor units in an externally fused bank with shorted internal elements should be replaced as detected.

If the unit capacitance is within tolerance, inspect the tank for bulges or other damage and the bushings for damage. Replace the capacitor with any such damage.

Note: Due to the process by which the capacitor units are filled with dielectric fluid, the tank will have inherently have a very slight bulge. This is normal.

5. Unscrew the fuse tube from the tube mounting and empty the remains of the operated fuse link.
6. Inspect the fuse tube for any signs of splitting, cracking, slight internal blockage, or separation of the tube barrel from the barrel mounting. Replace the fuse tube if any of these indications are found.
7. Insert an equivalent fuse link (Eaton recommends the use of non-removable buttonhead links) into the fuse tube. Snugly screw the fuse tube to the fuse tube mounting using a torque of 5 to 7 ft-lb (6.8 to 9.5 N-m).
8. Inspect the ejector spring. If it is physically distorted or the epoxy coating on the tip has been burned or worn away, replace it. See Service Information MN230005EN Expulsion Fuse Installation Instructions.
9. Reconnect the capacitor per Service Information MN230005EN Expulsion Fuse Installation Instructions, remove maintenance grounds and shorting gear.

Ordering replacement capacitor units

Replacement capacitor units should be rated for application in the particular capacitor bank. It must be an all-film design having the same kvar, voltage and frequency of the unit it is replacing. The parallel energy handling capability and BIL of the replacement unit must be equal to or greater than the unit it is replacing.

Field testing

Periodic testing of capacitors as a preventative maintenance function is not recommended. Occasionally, it is necessary to field test capacitors to determine if any damage or failure has occurred. This is particularly important if the capacitors have been subjected to unusual service conditions or if a number of series sections have recently failed at a capacitor installation.

Checking the capacitance of a unit is the best way to determine whether or not the capacitor is partially failed. High voltage insulation strength tests may be used on two-bushing capacitors in an effort to identify capacitors which would fail in the near future if they were re-energized. The results of this type of testing and the problems related to high-voltage testing in the field indicate that the value of this type of test is somewhat limited.

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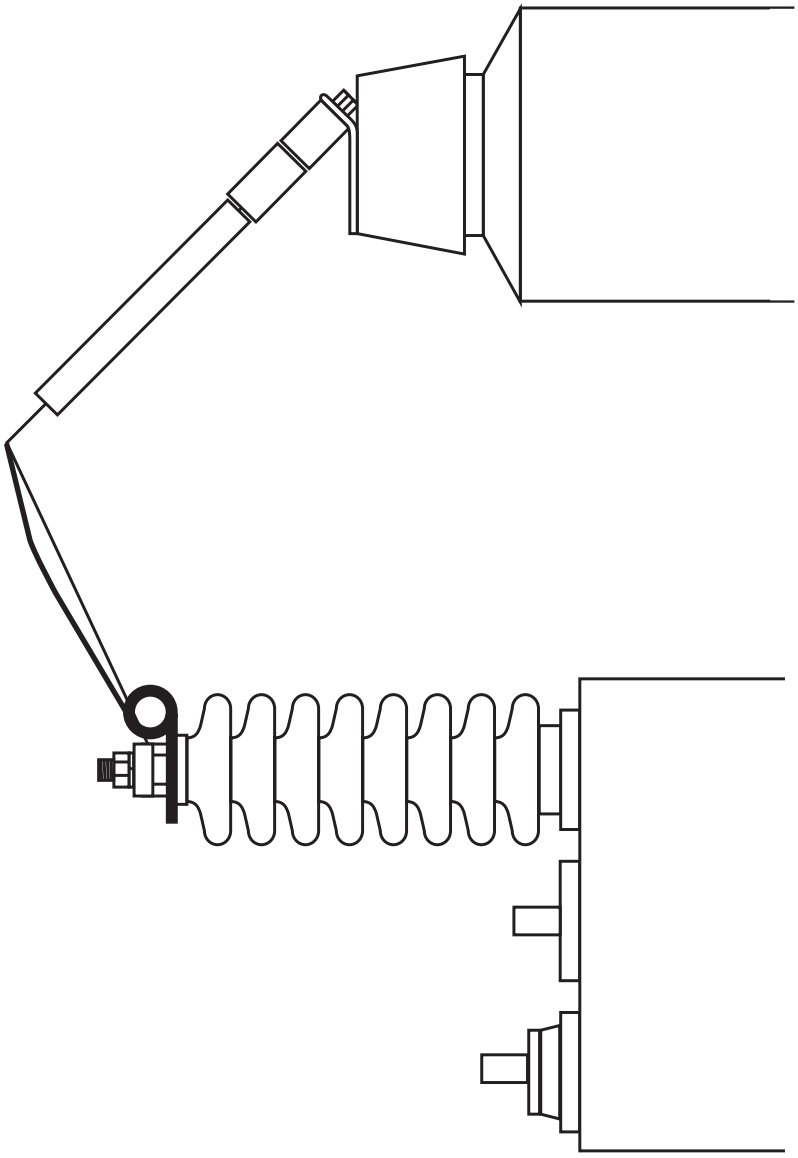
Expulsion fuse installation instructions



Powering Business Worldwide

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Contents

Safety for life

Eaton's Cooper Power series products meet or exceed all applicable industry standards relating to product safety. We actively promote safe practices in the use and maintenance of our products through our service literature, instructional training programs, and the continuous efforts of all Eaton employees involved in product design, manufacture, marketing and service.

We strongly urge that you always follow all locally approved safety procedures and safety instructions when working around high-voltage lines and equipment and support our "Safety For Life" mission.

Safety information

The instructions in this manual are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described. Only competent technicians, who are familiar with this equipment should install, operate and service it.

A competent technician has these qualifications:

- Is thoroughly familiar with these instructions.
- Is trained in industry-accepted high- and low-voltage safe operating practices and procedures.
- Is trained and authorized to energize, de-energize, clear, and ground power distribution equipment.
- Is trained in the care and use of protective equipment such as flash clothing, safety glasses, face shield, hard hat, rubber gloves, hotstick, etc.

Following is important safety information. For safe installation and operation of this equipment, be sure to read and understand all cautions and warnings.

Hazard Statement Definitions

This manual may contain four types of hazard statements:

⚠ DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially hazardous situation which, if not avoided, could result In death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in equipment damage only.

Safety instructions

Following are general caution and warning statements that apply to this equipment. Additional statements, related to specific tasks and procedures, are located throughout the manual.

⚠ DANGER

Hazardous voltage. Contact with high voltage will cause death or severe personal injury. Follow all locally approved safety procedures when working around high- and low-voltage lines and equipment.

⚠ WARNING

Before installing, operating, maintaining, or testing this equipment, carefully read and understand the contents of this manual. Improper operation, handling or maintenance can result in death, severe personal injury, and equipment damage.

⚠ WARNING

This equipment is not intended to protect human life. Follow all locally approved procedures and safety practices when installing or operating this equipment. Failure to comply may result in death, severe personal injury and equipment damage.

⚠ WARNING

Power distribution equipment must be selected for the intended application. It must be installed and serviced by competent personnel who have been trained and understand proper safety procedures. These instructions are written for such personnel and are not a substitute for adequate training and experience in safety procedures. Failure to properly select, install or maintain this equipment can result in death, severe personal injury, and equipment damage.

Expulsion fuse operation

An expulsion fusing system as used for protecting capacitors consists of three components which include the fuse tube, the fuse link, and the ejector spring (Figure 1). The proper operation of a fuse is dependent upon these components working in close harmony with each other.

Proper assembly of the fusing system is critical to the successful operation of the fusing system whereas incorrect installation may result in severe damage to the fuses, the capacitors, and/or capacitor bank.

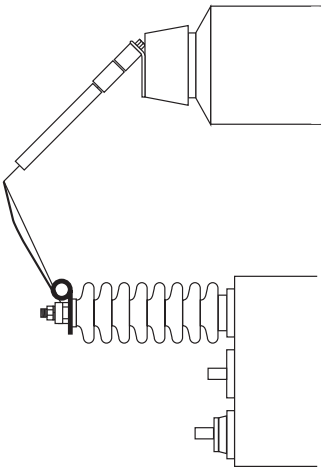

Figure 1. Expulsion fusing system components

When an excessive amount of current flows through the fuse link, the fusible portion of the link melts. This creates an arc where the fuse element was present which maintains a current path through the fuse assembly.

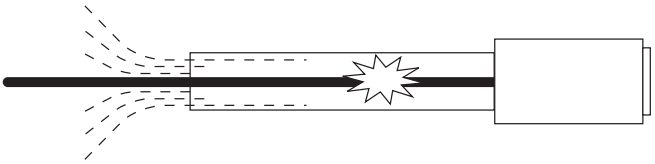

Figure 2. Initial operation of fuse link

The fuse tube is lined with a material which gases freely when heated by the arc. This gas vents through the open end of the fuse tube and forces the severed portion of the fuse link's leader wire towards the end of the tube. Both of these actions assist in the process of arc quenching by lengthening the arc and extinguishing it (Figure 2).

Successful interruption of the circuit will occur when sufficient dielectric strength exists within the gap to prevent re-establishment of the arc once the voltage across the gap begins to build. This interruption occurs either at a system frequency (50 Hz or 60 Hz) current zero or a higher frequency current zero created by the inductance and capacitance of the individual capacitor block.

As the amount of gas generation is dependent upon the amount of current being interrupted, the force with which the leader is ejected from the tube will also vary. Under high energy conditions, the sole purpose of the ejector spring is to control the motion of the ejected leader once it is in free air. For low energy interruptions, the ejector spring also serves to assist in the process of lengthening the arc and becomes an active component in the interruption mechanism of the fusing system.

Each individual capacitor fuse has a specific rating and has been selected based upon the voltage and kvar rating of the capacitor. See **Fuse Tube Ratings** (Table 1) for specific information regarding the interrupting ratings of the fuse tubes. The catalog number of the replacement fuse link, fuse tube, and fuse ejector spring is listed on the index sheet of the capacitor bank instruction manual.

Horizontal fuse installation

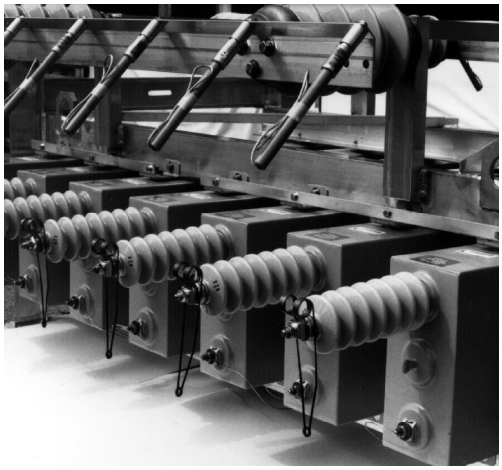

Figure 3.

1. Receiving instructions

Figure 3 illustrates the method used to assemble the fuse prior to shipment of the capacitor bank. The fuse holder, fuse tube, and fuse link are mounted to the fuse bus with the lead wire of the fuse link taped to the fuse tube. This method of shipping prevents damage to the fuse assembly during shipment.

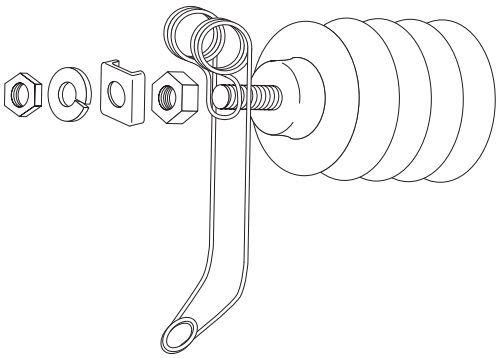

Figure 4.

The ejector spring is mounted to the capacitor terminal, and a heavy hex nut is provided to tighten the ejector spring in place. A clamp, lock washer, and second nut are provided to attach the fuse link lead wire to the capacitor terminal. Figure 4 illustrates the hardware arrangement onto the capacitor terminal.

Note: If the capacitors, fuses and ejector springs are shipped separately to be installed by the customer, all hardware will be included to properly assemble on the capacitor terminal.

2. Ejector spring alignment

The ejector spring and heavy hex nut should be placed on the capacitor terminal in the order shown in Figure 4.

Align the ejector spring horizontally and vertically to achieve two objectives:

A. The ejector spring must move in a true vertical plane as it rotates from its resting position to its working position at the end of the fuse tube.

B. When the ejector spring is rotated up to its working position at the end of the fuse tube, there should be no more than one inch (25.4 mm) from the top of the ejector spring eye to the edge of the fuse tube.

After proper alignment, tighten the inner nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).

3. Fuse leader assembly

A. Carefully remove the tape from the fuse tube and the leader wire used to secure the wire during shipment.

B. Straighten the fuse link leader such that there are no entanglements (Figure 5).

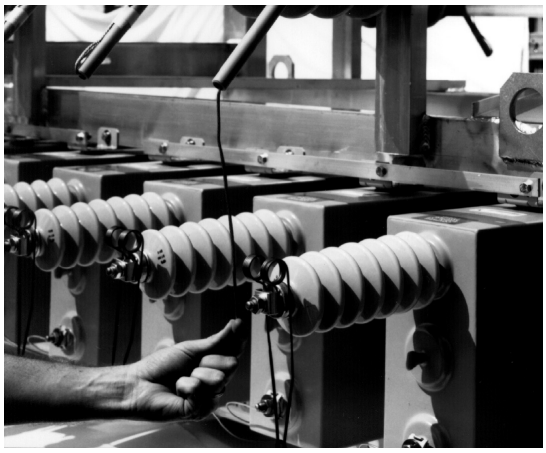

Figure 5.

C. Thread the fuse link lead wire through the eye of the ejector spring as shown in Figure 6. It is important the lead wire be routed over the top of the eye then back through the eye as displayed. Pull the eye of the ejector spring to a point where it touches (or is directly beneath) the end of the fuse tube.

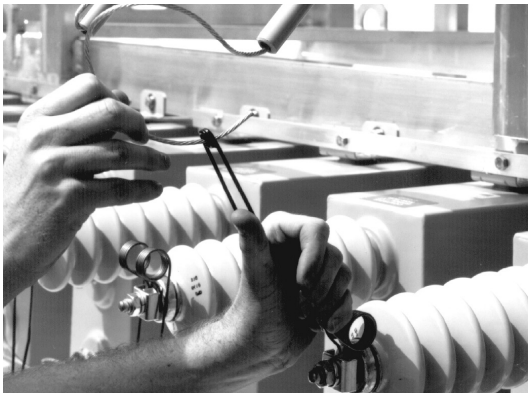

Figure 6.

D. Wrap the end of the fuse link lead wire around the threaded stud of the capacitor terminal (between the heavy hex nut and the clamp) (Figure 7). Place the lock washer on top of the clamp taking care to assure the split in the washer is not aligned with the open end of the clamp. Tighten the outer nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).

Note: An additional check of the torque may be required after several days. The fuse leader wire may "flow" from the compressed area requiring additional tightening of the outer nut to the proper torque value.

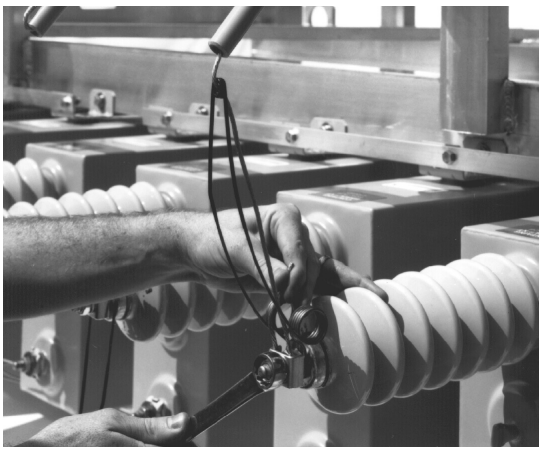

Figure 7.

E. Trim the excess fuse link lead wire (Figure 8). Approximately 3/8 inch (1 centimeter) of lead wire should extend beyond the clamp assembly.

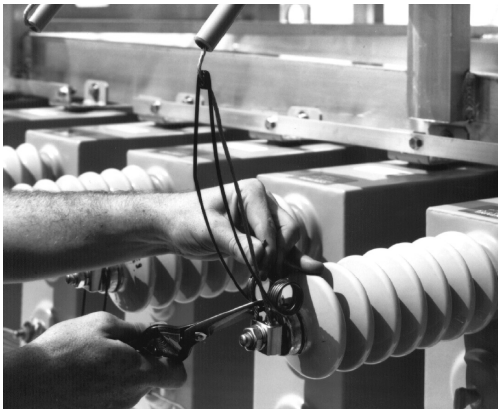

Figure 8.

F. Check the fuse ejector spring for proper working position and alignment.

Figure 9.

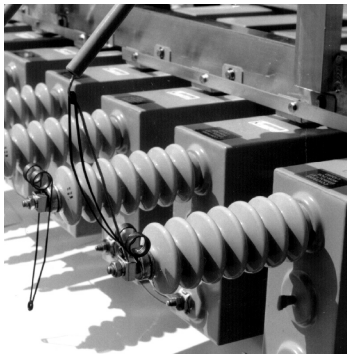

Figure 10.

Vertical fuse installation

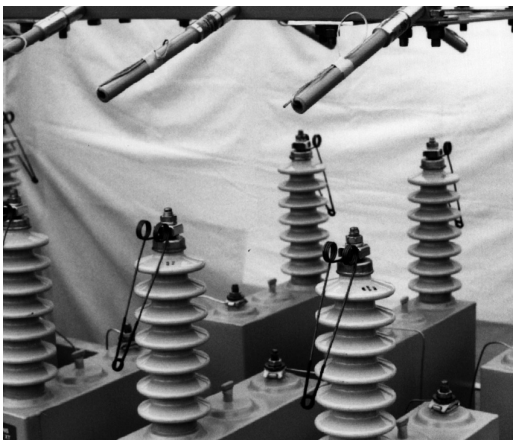

Figure 11.

1. Receiving instructions

Figure 11 illustrates the method used to assemble the fuse prior to shipment of the capacitor bank. The fuse holder, fuse tube, and fuse link are mounted to the fuse bus with the lead wire of the fuse link taped to the fuse tube. This method of shipping prevents damage to the fuse assembly during shipment.

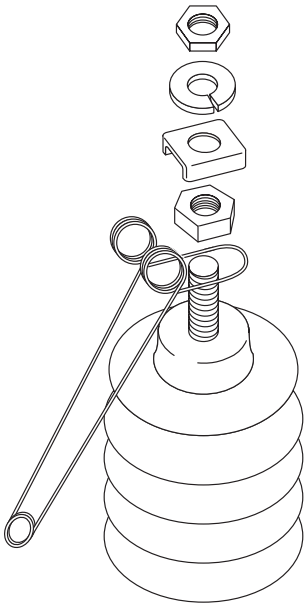

Figure 12.

The ejector spring is mounted to the capacitor terminal, and a heavy hex nut is provided to tighten the ejector spring in place. A clamp, lock washer, and second nut are provided to attach the fuse link lead wire to the capacitor terminal. Figure 12 illustrates the hardware arrangement onto the capacitor terminal.

Note: If the capacitors, fuses and ejector springs are shipped separately to be installed by the customer, all hardware will be included to properly assemble on the capacitor terminal.

2. Ejector spring alignment

The ejector spring and heavy hex nut should be placed on the capacitor terminal in the order shown in Figure 12.

Align the ejector spring horizontally and vertically to achieve two objectives:

A. The ejector spring must move in a true vertical plane as it rotates from its resting position to its working position at the end of the fuse tube.

B. When the ejector spring is rotated up to its working position at the end of the fuse tube, there should be no more than one inch (25.4 mm) from the top of the ejector spring eye to the edge of the fuse tube.

After proper alignment, tighten the inner nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).

3. Fuse leader assembly

A. Carefully remove the tape from the fuse tube and leader wire used to secure the wire during shipment.

B. Straighten the fuse link leader such that there are no entanglements (Figure 13).

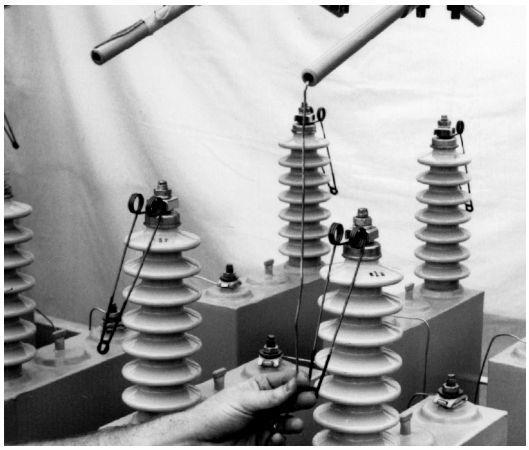

Figure 13.

C. Thread the fuse link lead wire through the eye of the ejector spring as shown in Figure 14. It is important the lead wire be routed over the top of the eye then back through the eye as displayed. Pull the eye of the ejector spring to a point where it touches (or is directly beneath) the end of the fuse tube.

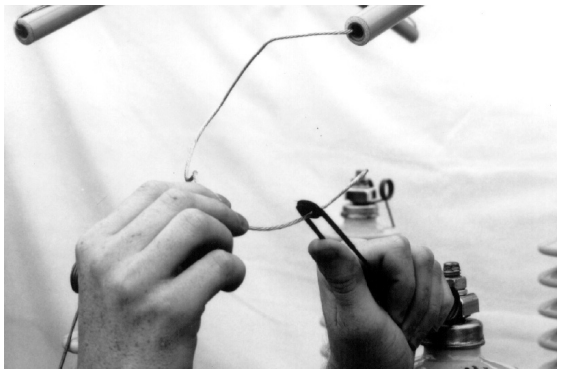

Figure 14.

D. Wrap the end of the fuse link lead wire around the threaded stud of the capacitor terminal (between the heavy hex nut and the clamp) (Figure 15). Place the lock washer on top of the clamp taking care to assure the split in the washer is not aligned with the open end of the clamp. Tighten the outer nut using a torque of 16 to 19 ft-lb (21.7 to 25.8 N-m).

Note: An additional check of the torque may be required after several days. The fuse leader wire may "flow" from the compressed area requiring additional tightening of the outer nut to the proper torque value.

Figure 15.

E. Trim the excess fuse link lead wire (Figure 16). Approximately 3/8 inch (1 centimeter) of lead wire should extend beyond the clamp assembly.

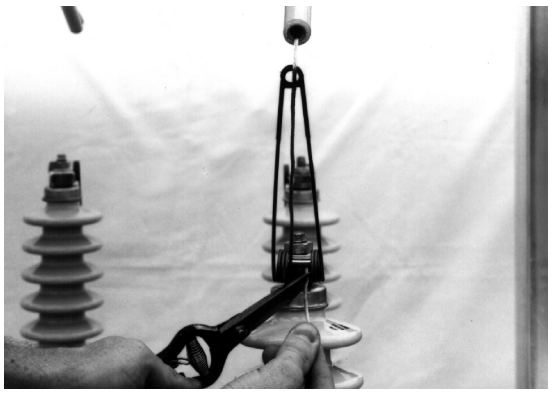

Figure 16.

F. Check the fuse ejector spring for proper working position and alignment.

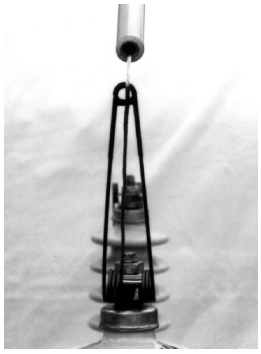

Figure 17.

Figure 18.

Fuse tube ratings

Fuse tube design features

The fuse tube is constructed of bone-grade fiber over-wrapped with epoxy-bonded filament-wound fiberglass or grade XX phenolic. The upper contact, depending on the rating, is either aluminum or tin-plated bronze. The fuseholder accepts ANSI standard removable or non-removable buttonhead fuse links.

The function of the fuse tube is to confine the arc and produce arc-quenching gases which are expelled from the end of the tube.

Voltage stress across the fuse tube is eliminated by the gap between the end of the tube and the capacitor terminal. There is no possibility of tracking and eventual flashover, even after exposure to weather and contaminants. When the spring ejects the leader, positive indication of a blown fuse can also be easily detected from a distance.

Table 1. Fuse tube ratings

Fuse voltage rating (kV)	Capacitor mounting configuration (H or V)*	Current rating (A)	Power frequency interrupting rating (A)		Maximum parallel-connected energy (kJ)**	Catalog number
			Symmetrical	Asymmetrical		
8.7	H	50	3600	5000	20	FN10B4
8.7	H	80	3600	5000	30	FN20B2
8.7	V	50	3600	5000	20	FN10B4
8.7	V	80	3600	5000	30	FN20B2
15.5	H	50	3600	5000	20	FN11B2
15.5	H	80	3600	5000	30	FN20B2
15.5	V	50	3600	5000	20	FN11B2
15.5	V	80	3600	5000	30	FN20B2
23.0	H	50	1800	2500	20	FN11B2
23.0	H	80	1800	2500	30	FN11B3
23.0	V	50	1800	2500	20	FN11B2
23.0	V	80	1800	2500	30	FN11B3

*H = Horizontal, V = Vertical

**When used with the recommended unit spacing per IEEE Std 18-2012 and Eaton's Cooper Power series' type SD, HD or XD capacitor units.

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Recommended Refusing Procedure
For An Operated Expulsion Fuse Assembly

1. Isolate and de-energize the equipment containing the operated fuse and short the capacitor assembly to ground.

2. Check the capacitor (that contains the operated fuse) with capacitor metering equipment to verify that it is within tolerance. (Reference Service Information bulletin MN230002EN for capacitance tolerances.) If the unit is not, remove the capacitor from the bank and-replace it with a good unit.

3. Disconnect and manually short the terminals of the capacitor together.

4. Unscrew the fuse tube from the tube mounting and empty the remains of the operated fuse link.

5. Inspect the fuse tube for any signs of splitting, cracking, slight internal blockage, or separation of the tube barrel from the barrel mounting. Replace the fuse tube if any of these indications are found.

6. Insert an equivalent fuse link replacement (Eaton recommends to use a non-removable buttonhead type) into the fuse tube. Snugly screw the fuse tube to the fuse tube mounting (approximately 5 - 7 ft-lbs. of torque).

7. The ejector spring should be inspected and replaced if it is physically distorted or the epoxy coating on the tip has been burned or worn away. Reference Service Information bulletin MN230006EN for expulsion fuse installation instructions.

8. Reconnect the capacitor, remove the temporary ground short of the assembly, and reenergize the equipment.

SAFETY DATA SHEET

1. Identification

Product identifier **Edisol VI**

Other means of identification

Product code CCZ175A

Recommended use Dielectric Fluid.

Recommended restrictions None known.

Manufacturer/Importer/Supplier/Distributor information

Company Cooper Power Systems, LLC
1520 Emerald Rd.
Greenwood, SC 29646

Telephone Number 864-941-2311

Emergency Telephone Number 760-476-3962

2. Hazard(s) identification

Physical hazards Not classified.

Health hazards	Skin corrosion/irritation	Category 2
	Aspiration hazard	Category 1
Environmental hazards	Hazardous to the aquatic environment, acute hazard	Category 2
	Hazardous to the aquatic environment, long-term hazard	Category 2

OSHA defined hazards Not classified.

Label elements

Signal word Danger

Hazard statement May be fatal if swallowed and enters airways. Causes skin irritation. Toxic to aquatic life. Toxic to aquatic life with long lasting effects.

Precautionary statement

Prevention Wash thoroughly after handling. Avoid release to the environment. Wear protective gloves.

Response If swallowed: Immediately call a poison center/doctor. If on skin: Wash with plenty of water. Do NOT induce vomiting. If skin irritation occurs: Get medical advice/attention. Take off contaminated clothing and wash it before reuse. Collect spillage.

Storage Store locked up.

Disposal Dispose of contents/container in accordance with local/regional/national/international regulations.

Hazard(s) not otherwise classified (HNOC) None known.

Supplemental information None.

3. Composition/information on ingredients

Mixtures

Chemical name	CAS number	%
1,1-Diphenylethane	612-00-0	50-60

Benzyltoluene	27776-01-8	36-50
Diphenylmethane	101-81-5	<4
1,2-Diphenylethane	103-29-7	<2

All concentrations are in percent by weight (kg) unless ingredient is a gas. Gas concentrations are in percent by volume (l).

4. First-aid measures

Inhalation Move to fresh air. Call a physician if symptoms develop or persist.

Skin contact Remove contaminated clothing. Wash with plenty of soap and water. If skin irritation occurs: Get medical advice/attention. Wash contaminated clothing before reuse.

Eye contact Rinse with water. Get medical attention if irritation develops and persists.

Ingestion Call a physician or poison control center immediately. Rinse mouth. Do not induce vomiting. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs.

Most important symptoms/effects, acute and delayed Aspiration may cause pulmonary edema and pneumonitis. Skin irritation. May cause redness and pain.

Indication of immediate medical attention and special treatment needed Provide general supportive measures and treat symptomatically. Keep victim under observation. Symptoms may be delayed.

General information Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire-fighting measures

Suitable extinguishing media Water fog. Foam. Dry chemical powder. Carbon dioxide (CO2).

Unsuitable extinguishing media Do not use water jet as an extinguisher, as this will spread the fire.

Specific hazards arising from the chemical During fire, gases hazardous to health may be formed.

Special protective equipment and precautions for firefighters Self-contained breathing apparatus and full protective clothing must be worn in case of fire.

Fire fighting equipment/instructions Move containers from fire area if you can do so without risk.

General fire hazards No unusual fire or explosion hazards noted.

6. Accidental release measures

Personal precautions, protective equipment and emergency procedures Keep unnecessary personnel away. Keep people away from and upwind of spill/leak. Wear appropriate protective equipment and clothing during clean-up. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing. Ensure adequate ventilation. Local authorities should be advised if significant spillages cannot be contained. For personal protection, see section 8 of the SDS.

Methods and materials for containment and cleaning up Prevent product from entering drains.

Large Spills: Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Absorb in vermiculite, dry sand or earth and place into containers. Following product recovery, flush area with water.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills to original containers for re-use. For waste disposal, see section 13 of the SDS.

Environmental precautions Avoid release to the environment. Inform appropriate managerial or supervisory personnel of all environmental releases. Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.

7. Handling and storage

Precautions for safe handling Provide adequate ventilation. Avoid contact with eyes, skin, and clothing. Wear appropriate personal protective equipment. Wash hands thoroughly after handling. Observe good industrial hygiene practices.

Conditions for safe storage, including any incompatibilities Store locked up. Store in original tightly closed container. Store away from incompatible materials (see Section 10 of the SDS).

8. Exposure controls/personal protection

Occupational exposure limits

US. Workplace Environmental Exposure Level (WEEL) Guides

Components	Type	Value
1,1-Diphenylethane (CAS 612-00-0)	TWA	7.8 mg/m3
		1 ppm

Biological limit values No biological exposure limits noted for the ingredient(s).

Appropriate engineering controls Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level. Eye wash facilities and emergency shower must be available when handling this product.

Individual protection measures, such as personal protective equipment

Eye/face protection Wear safety glasses with side shields (or goggles).

Skin protection

Hand protection Wear appropriate chemical resistant gloves. Suitable gloves can be recommended by the glove supplier.

Skin protection

Other Wear appropriate chemical resistant clothing. Use of an impervious apron is recommended.

Respiratory protection In case of insufficient ventilation, wear suitable respiratory equipment.

Thermal hazards Wear appropriate thermal protective clothing, when necessary.

General hygiene considerations Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

9. Physical and chemical properties

Appearance

Physical state Liquid.

Form Liquid.

Color Clear.

Odor Aromatic.

Odor threshold Not available.

pH Not available.

Melting point/freezing point -67 - -58 °F (-55 - -50 °C)

Initial boiling point and boiling range Not available.

Flash point 282.2 °F (139.0 °C) Cleveland Open Cup

Evaporation rate Not available.

Flammability (solid, gas) Not applicable.

Upper/lower flammability or explosive limits

Flammability limit - lower (%) Not available.

Flammability limit - upper (%) Not available.

Explosive limit - lower (%) Not available.

Explosive limit - upper (%) Not available.

Vapor pressure 0.00005 psi (21.1°C / 70°F)

Vapor density 6.3 (Air= 1)

Relative density Not available.

Solubility(ies)

Solubility (water) 5 ppm In water.

Partition coefficient (n-octanol/water)	Not available.
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Viscosity	Not available.

Other information

Explosive properties	Not explosive.
Oxidizing properties	Not oxidizing.

10. Stability and reactivity

Reactivity	The product is stable and non-reactive under normal conditions of use, storage and transport.
Chemical stability	Material is stable under normal conditions.
Possibility of hazardous reactions	No dangerous reaction known under conditions of normal use.
Conditions to avoid	Contact with incompatible materials.
Incompatible materials	Strong oxidizing agents.
Hazardous decomposition products	No hazardous decomposition products are known.

11. Toxicological information

Information on likely routes of exposure

Inhalation	Prolonged inhalation may be harmful.
Skin contact	Causes skin irritation.
Eye contact	Direct contact with eyes may cause temporary irritation.
Ingestion	Droplets of the product aspirated into the lungs through ingestion or vomiting may cause a serious chemical pneumonia.
Symptoms related to the physical, chemical and toxicological characteristics	Aspiration may cause pulmonary edema and pneumonitis. Skin irritation. May cause redness and pain.

Information on toxicological effects

Acute toxicity	May be fatal if swallowed and enters airways.
Skin corrosion/irritation	Causes skin irritation.
Serious eye damage/eye irritation	Direct contact with eyes may cause temporary irritation.

Respiratory or skin sensitization

Respiratory sensitization	Not a respiratory sensitizer.
Skin sensitization	This product is not expected to cause skin sensitization.
Germ cell mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

IARC Monographs. Overall Evaluation of Carcinogenicity

Not listed.

NTP Report on Carcinogens

Not listed.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

Reproductive toxicity	Based on available data, the classification criteria are not met.
Specific target organ toxicity - single exposure	Not classified.
Specific target organ toxicity - repeated exposure	Not classified.
Aspiration hazard	May be fatal if swallowed and enters airways.
Chronic effects	Prolonged inhalation may be harmful.

12. Ecological information

Ecotoxicity Toxic to aquatic life with long lasting effects.

Persistence and degradability No data is available on the degradability of this product.

Bioaccumulative potential

Partition coefficient n-octanol / water (log Kow)

Diphenylmethane (CAS 101-81-5)	4.14

Mobility in soil Expected to be mobile in soil.

Other adverse effects No other adverse environmental effects (e.g. ozone depletion, photochemical ozone creation potential, endocrine disruption, global warming potential) are expected from this component.

13. Disposal considerations

Disposal instructions Collect and reclaim or dispose in sealed containers at licensed waste disposal site. Do not allow this material to drain into sewers/water supplies. Do not contaminate ponds, waterways or ditches with chemical or used container. Dispose of contents/container in accordance with local/regional/national/international regulations.

Local disposal regulations Dispose in accordance with all applicable regulations.

Hazardous waste code The waste code should be assigned in discussion between the user, the producer and the waste disposal company.

Waste from residues / unused products Dispose of in accordance with local regulations. Empty containers or liners may retain some product residues. This material and its container must be disposed of in a safe manner (see: Disposal instructions).

Contaminated packaging Since emptied containers may retain product residue, follow label warnings even after container is emptied. Empty containers should be taken to an approved waste handling site for recycling or disposal.

14. Transport information

DOT

UN number	UN3082
UN proper shipping name	Environmentally hazardous substances, liquid, n.o.s. (Diphenylmethane)
Transport hazard class(es)	
Class	9
Subsidiary risk	-
Label(s)	9
Packing group	III
Environmental hazards	
Marine pollutant	Yes
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Special provisions	8, 146, 335, IB3, T4, TP1, TP29
Packaging exceptions	155
Packaging non bulk	203
Packaging bulk	241

IATA

UN number	UN3082
UN proper shipping name	Environmentally hazardous substance, liquid, n.o.s. (Diphenylmethane)
Transport hazard class(es)	
Class	9
Subsidiary risk	-
Label(s)	9
Packing group	III
Environmental hazards	Yes
ERG Code	9L
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.

IMDG

UN number	UN3082
UN proper shipping name	ENVIRONMENTALLY HAZARDOUS SUBSTANCE, LIQUID, N.O.S. (Diphenylmethane)
Transport hazard class(es)	
Class	9
Subsidiary risk	-
Label(s)	9

Packing group	III
Environmental hazards	
Marine pollutant	Yes
EmS	F-A, S-F
Special precautions for user	Read safety instructions, SDS and emergency procedures before handling.
Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code	Not established.

15. Regulatory information

US federal regulations This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

TSCA Section 12(b) Export Notification (40 CFR 707, Subpt. D)

Not regulated.

OSHA Specifically Regulated Substances (29 CFR 1910.1001-1050)

Not regulated.

CERCLA Hazardous Substance List (40 CFR 302.4)

Not listed.

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories Immediate Hazard - Yes
Delayed Hazard - No
Fire Hazard - No
Pressure Hazard - No
Reactivity Hazard - No

SARA 302 Extremely hazardous substance

Not listed.

SARA 311/312 Hazardous chemical Yes

SARA 313 (TRI reporting)

Not regulated.

Other federal regulations

Clean Air Act (CAA) Section 112 Hazardous Air Pollutants (HAPs) List

Not regulated.

Clean Air Act (CAA) Section 112(r) Accidental Release Prevention (40 CFR 68.130)

Not regulated.

Safe Drinking Water Act (SDWA) Not regulated.

US state regulations

US. Massachusetts RTK - Substance List

Not regulated.

US. New Jersey Worker and Community Right-to-Know Act

Not listed.

US. Pennsylvania Worker and Community Right-to-Know Law

Not listed.

US. Rhode Island RTK

Not regulated.

US. California Proposition 65

California Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65): This material is not known to contain any chemicals currently listed as carcinogens or reproductive toxins.

International Inventories

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No

Country(s) or region	Inventory name	On inventory (yes/no)*
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	No
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates this product complies with the inventory requirements administered by the governing country(s).
A "No" indicates that one or more components of the product are not listed or exempt from listing on the inventory administered by the governing country(s).

16. Other information, including date of preparation or last revision

Issue date 16-February-2016

Revision date -

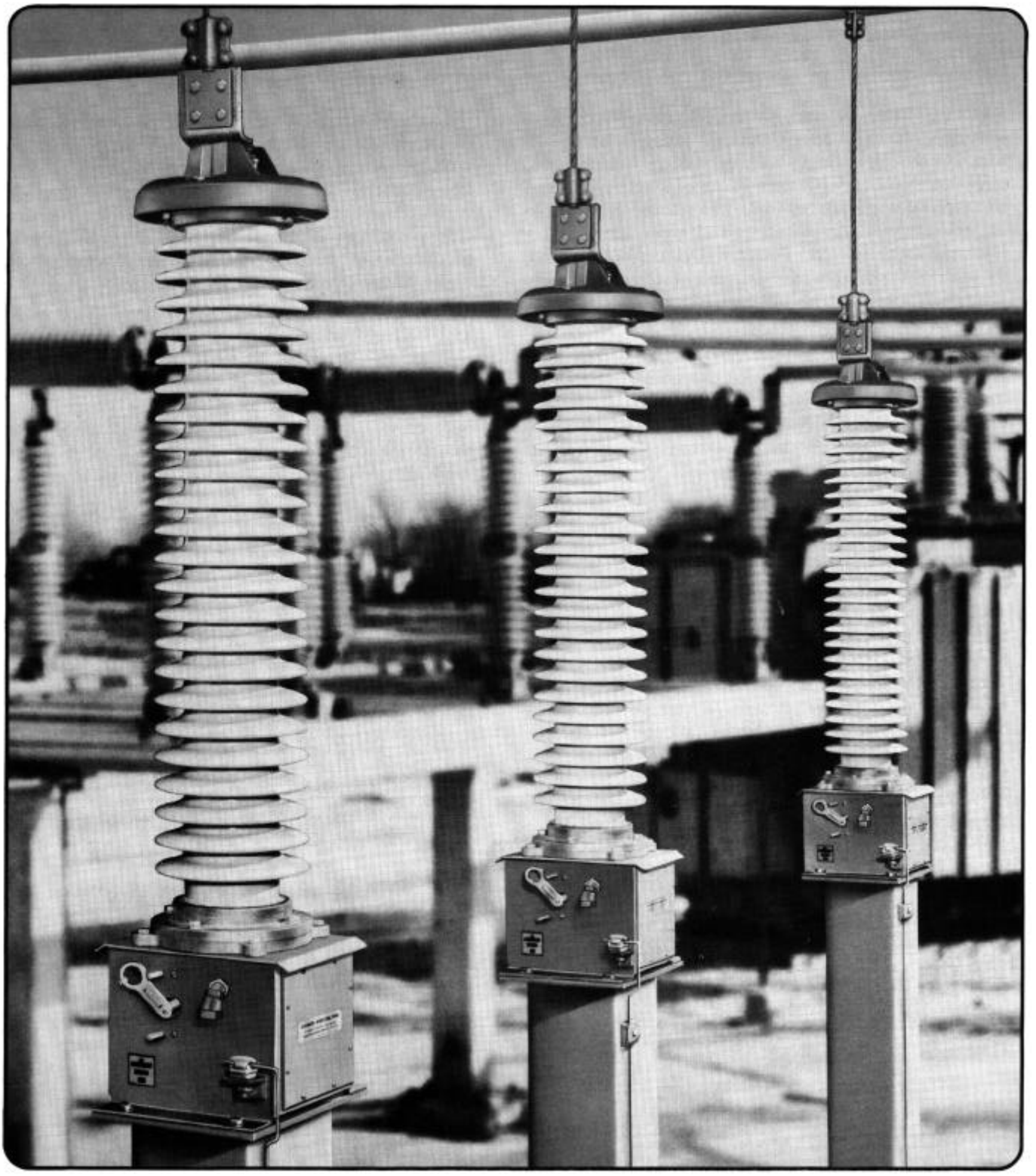
Version # 01

HMIS® ratings
Health: 2
Flammability: 1
Physical hazard: 0

NFPA ratings

References
IARC: International Agency for Research on Cancer.
ECHA CHEM
OECD. Program to investigate the potential hazards of high production volume chemicals (HPV)

Disclaimer
Cooper Power cannot anticipate all conditions under which this information and its product, or the products of other manufacturers in combination with its product, may be used. It is the user's responsibility to ensure safe conditions for handling, storage and disposal of the product, and to assume liability for loss, injury, damage or expense due to improper use. The information in the sheet was written based on the best knowledge and experience currently available.



S&C Potential Devices

Outdoor (23 kv through 138 kv)

■ **for relaying** ■ **for monitoring** ■ **for nonrevenue metering**

Supersedes Descriptive Bulletin 581-30 dated 7-27-81

S&C ELECTRIC COMPANY · Chicago
S&C ELECTRIC CANADA LTD · Rexdale

DESCRIPTIVE BULLETIN 581-30
Page 1 of 11
June 24, 1985

APPLICATION AND PERFORMANCE

S&C Potential Devices are resistance-type voltage-sensing units which offer significant savings-up to 70% over conventional single-bushing voltage transformers. They are suitable for a wide range of single-phase and three-phase applications, from 23 kv through 138 kv-including relaying, monitoring, and nonrevenue metering. And because S&C Potential Devices are accurate to within 1½%, they are suitable for virtually any protection scheme. The diagrams on pages 4, 5, and 6 show some of the ways they can be used.

Unlike capacitor-coupled devices, S&C Potential Devices do not possess resonant characteristics and are immune to ferroresonance. Their limited frequency response makes them ideal for service at locations where high-frequency transients might otherwise cause spurious relay operations.

And, unlike voltage transformers, S&C Potential Devices do not saturate when subjected to switching overvoltages. They are therefore better suited to neutral-voltage monitoring applications in shunt capacitor-bank and reactor protection schemes. Typically, in such applications, transient overvoltages on the order of 0.5 to 2.4 per unit can be developed at the neutral of the bank as a result of normal switching operations. S&C Potential Devices arc immune to these voltage surges. However, an underrated voltage transformer (used because of its lower turns ratio to obtain sufficient sensitivity in a monitoring scheme using electromechanical relays) can be driven into extreme saturation by these switching overvoltages-with resultant thermal failure of the windings or dielectric failure of the insulation.

S&C Potential Devices, like single-bushing voltage transformers, are rated in terms of system line-to-line voltage, but are connected line-to-ground.? S&C Potential Devices have constant-current output, like current transformers. With a fixed burden connected across the output terminals, S&C Potential Devices produce an output voltage that is directly proportional to the voltage applied to the line terminal.

S&C Potential Devices are very compact (see pages 9 and 10 for dimensions), requiring little room for installation. Although designed for outdoor use, they may be used indoors or in metal-enclosed switchgear. Special consideration to lightning exposure is not necessary. However, it is desirable, as with voltage transformers and other electrical apparatus, to provide surge arresters if the prevalence of lightning warrants.

The basic reliability of S&C resistance-type potential devices has been thoroughly proved in nearly 50 years of satisfactory field experience.

† S&C Potential Devices are rated for application on grounded systems, but application to ungrounded systems may be made through the use of specially applied or specially modified potential devices. A standard 30-volt-ampere potential device applied on an ungrounded system must have a system voltage rating at least equal to the system voltage multiplied by $\sqrt{3}$, and the burden impedance must not exceed the normal 480-ohm value (so that the high-voltage resistor assembly will not overheat and the output will not exceed 120 volts in the event of an accidental ground on the system). When a standard 30-volt-ampere potential device is applied as described, the nominal output is typically reduced to a maximum of 60 volts and 7.5 volt-amperes (48 volts and 4.8 volt-amperes for 46-kv ungrounded systems). Specially modified M-volt-ampere potential devices can be provided for ungrounded-system application with nominal output of 70 volts and 10 volt-amperes.

30-Volt-Ampere Models

Models having 30-volt-ampere output rating are suitable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. They have a nominal output voltage of 120 volts rms when a 480-ohm resistive burden is connected across the output terminals and line-to-ground voltage corresponding to rated system voltage is applied to the line terminal. These models may be used for any appropriate application requiring a voltage source, provided the burden is fixed and does not exceed the output rating of the potential device. However, larger inductive burdens (e.g., as high as 60 volt-amperes at 60° lagging phase angle) may be easily accommodated by connecting a suitable shunt capacitor across the burden for power-factor correction. Also, an adjustable phase-relation between input and output voltage may be readily achieved by connecting suitable power-factor correction elements across the burden. ▲

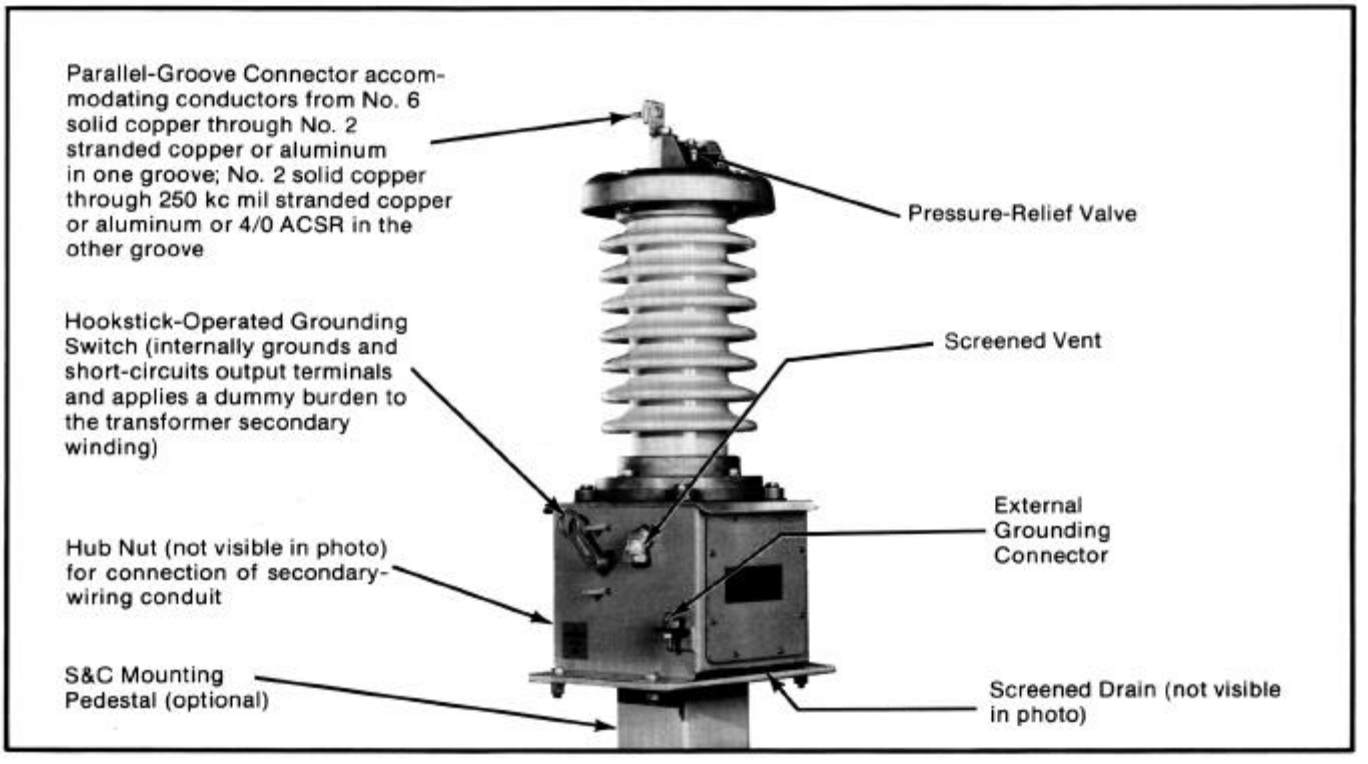
When used in conjunction with equipment having high-impedance input circuits, such as the S&C Automatic Control Device-Type GP, or with the unbalance compensation module option of S&C Automatic Control Device-Type UP or UPR, these potential devices must be equipped with a factory-adjusted calibration device (contained within the base of the potential device), catalog number suffix "-T." See page 8.

15-Volt-Ampere Models

Models having 15-volt-ampere output rating are applicable for neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors only. This application requires a much more sensitive potential device because of the very low voltage normally present between the neutral and ground. These models provide an output having excellent linearity and minimal phase shift at such low voltages. They have a secondary burden resistor contained within the base which has been factory calibrated to provide a specific voltage ratio. See page 8.

These models are intended for use in conjunction with equipment having high-impedance input circuits, such as S&C Automatic Control Devices-Types UP and UPR, and S&C Bankgard" Relay-Type LUC.

▲ For information on burden adjustments for these models, refer to S&C Instruction Sheet 581-500.

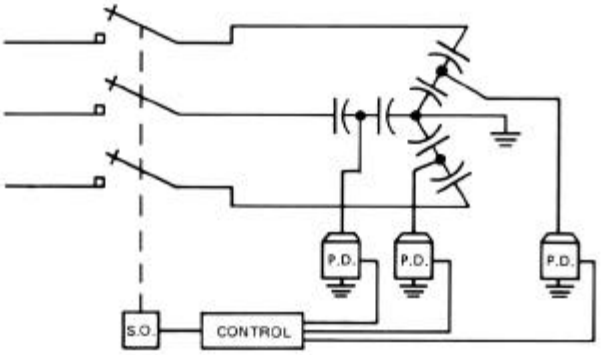


S&C 30-Volt-Ampere Potential Device, Catalog Number 81473R6-D, rated 23 kv.

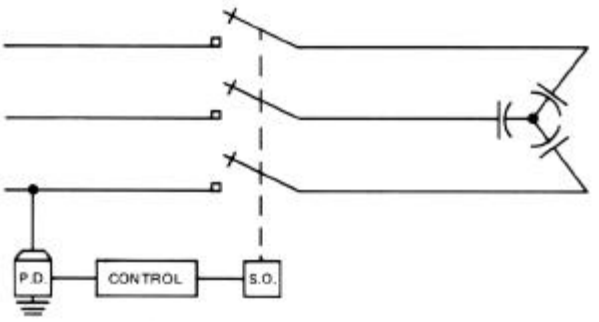
APPLICATION AND PERFORMANCE

TYPICAL APPLICATIONS FOR S&C 30-VOLT-AMPERE POTENTIAL DEVICES

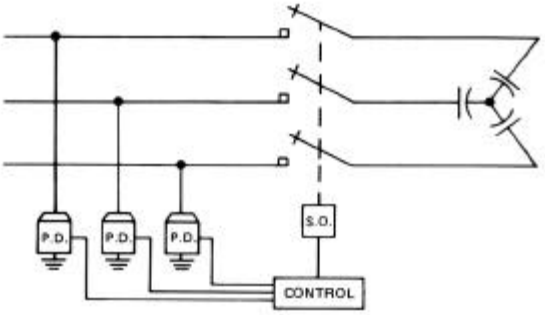
Monitoring intermediate-tap-point-to-ground voltage on grounded, wye-connected shunt capacitor bank, in conjunction with S&C Automatic Control Device—Type GP, for capacitor-bank protection.



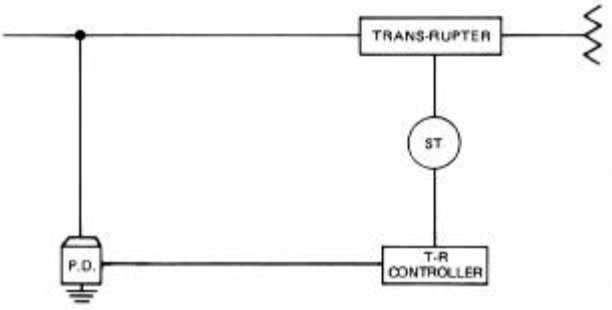
Monitoring system line-to-ground voltage, in conjunction with S&C Automatic Control Device—Type VR, for capacitor-bank switching for voltage regulation.



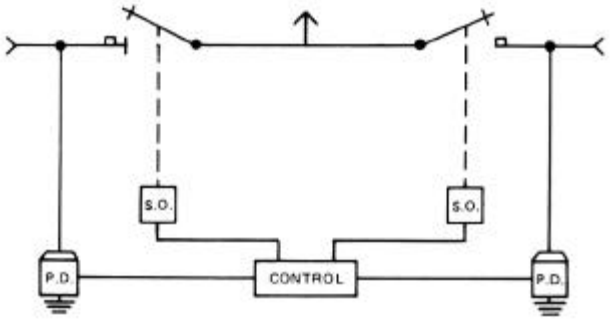
Monitoring system line-to-ground voltage, in conjunction with unbalance compensation module of S&C Automatic Control Device—Type UP or Type UPR, for protection of ungrounded, wye-connected shunt capacitor bank or reactor, respectively.



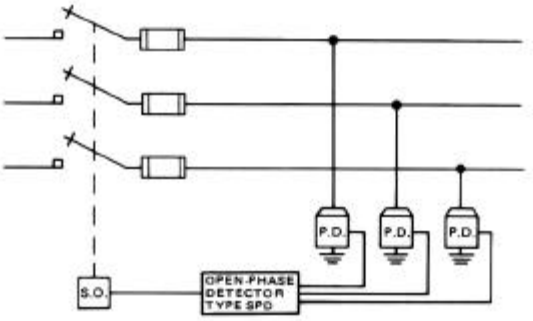
Providing control voltage to 115 volt, 60 hertz S&C Capacitor-Type Trans-Rupter™ Controller.



Monitoring system line-to-ground voltage, in conjunction with S&C Source-Transfer Control—Type AT, for automatic source transfer.

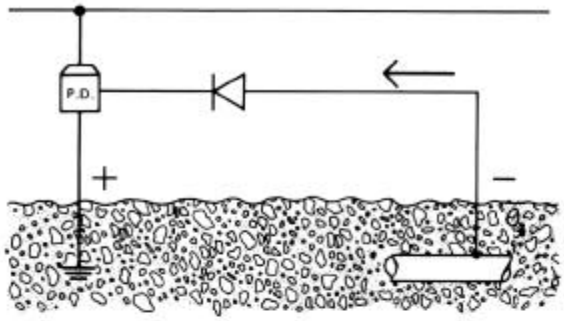


Monitoring line-to-ground voltage on three-phase load circuit, in conjunction with S&C Open-Phase Detector—Type SPD, for protection from open-phase conditions.

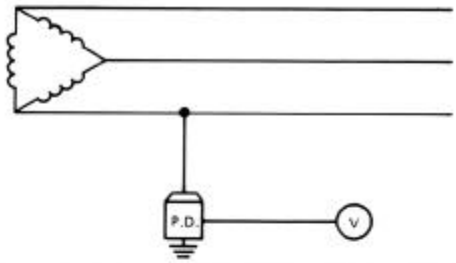


TYPICAL APPLICATIONS FOR S&C 30-VOLT-AMPERE POTENTIAL DEVICES - continued

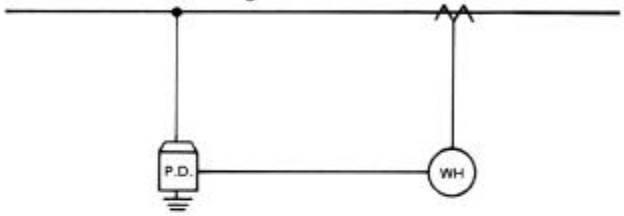
Cathodic corrosion protection. (Necessary burden resistance, surge protection, and rectifier can be included in the base of the potential device.)



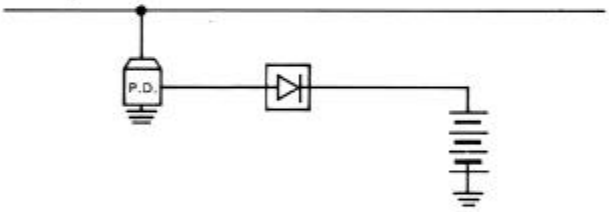
Detecting grounds using voltmeter, relaying, or indicating lamps. (See footnote† on page 2.)



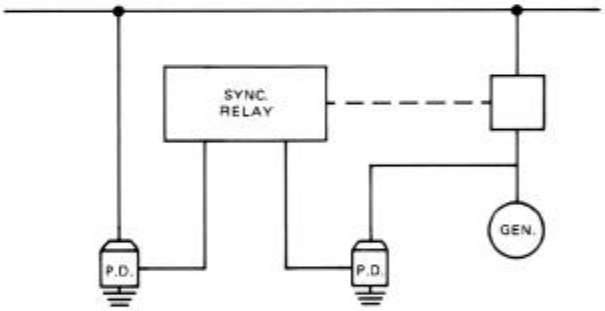
Nonrevenue metering.



Providing input voltage to S&C Constant-Burden Battery Charger.

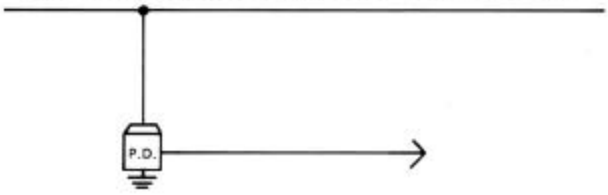


Monitoring system line-to-ground voltage magnitude and phase angle, in conjunction with synchronizing relays, for automatically synchronizing rotating machines onto a system.

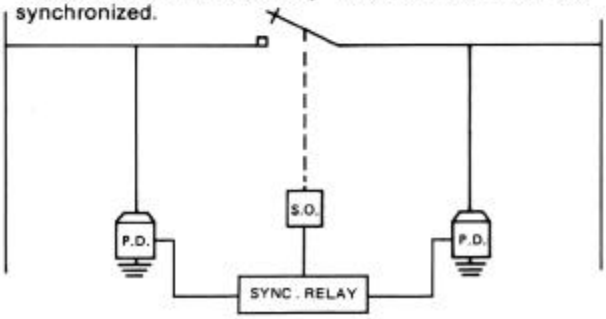


Providing input voltage for:

- Switching intelligence for load-shedding schemes.
- Special-purpose relays, e.g., ground-fault and voltage-unbalance relays.
- Control power at remote locations.
- Measurement with indicating or recording instruments.



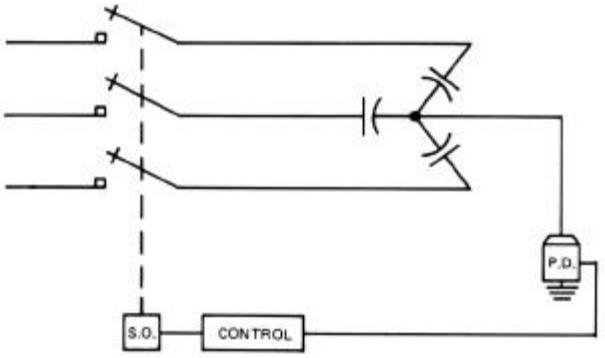
Monitoring system line-to-ground voltage magnitude and phase angle, in conjunction with synchronism-check relays, to permit closure of a switching device to interconnect two sources only when the sources are synchronized.



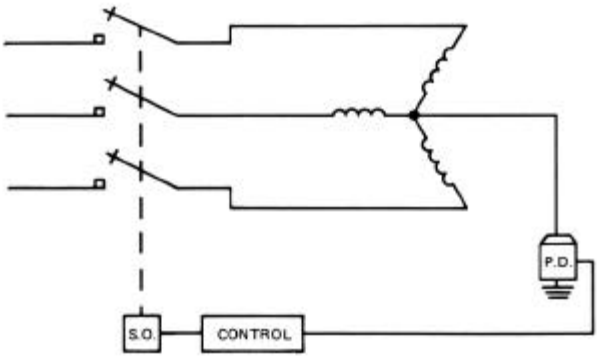
APPLICATION AND PERFORMANCE

APPLICATIONS FOR S&C 15-VOLT-AMPERE POTENTIAL DEVICES

Monitoring neutral-to-ground voltage on ungrounded, wye-connected shunt capacitor bank, in conjunction with S&C Automatic Control Device—Type UP or S&C Bank-gard™ Relay—Type LUC, for capacitor-bank protection.



Monitoring neutral-to-ground voltage on ungrounded, wye-connected shunt reactor, in conjunction with S&C Automatic Control Device—Type UPR, for reactor protection.



CONSTRUCTION

S&C Potential Devices utilize a high-voltage resistor assembly immersed in insulating oil and sealed in a wet-process porcelain bushing. A measured amount of air is left above the oil level to permit expansion and contraction of the oil volume with temperature changes; a pressure-relief valve is incorporated in the cover of the potential device to prevent excessive pressure buildup during normal operation under high-ambient-temperature conditions. Since the pressure-relief valve opens only if the internal pressure reaches a level of 9 to 11 psig, and then only momentarily, the resistor assembly is essentially sealed so that moisture contamination and sludging tendencies are virtually eliminated.

The resistor assembly comprises a large number of high-precision thick-metal-film resistors connected in series. Resistance values have been selected so that the current flow through the high-voltage resistor assembly of 30-volt-ampere models is approximately 4 milliamperes (less than 1 milliampere for 15-volt-ampere models). The individual resistors have a temperature coefficient of less than 0.01% per degree C, over a temperature range of –55°C to +175°C, assuring an exceptionally high degree of temperature stability.

At the base of the device, a stud connected to the resistor assembly is brought through an O-ring sealed Cypoxy®‡ insulator plate into the base enclosure, where connection is made to the primary side of the series transformer, and to a sparkover gap which limits high voltages which might appear at the transformer primary due to line surges or an inadvertent open secondary circuit.

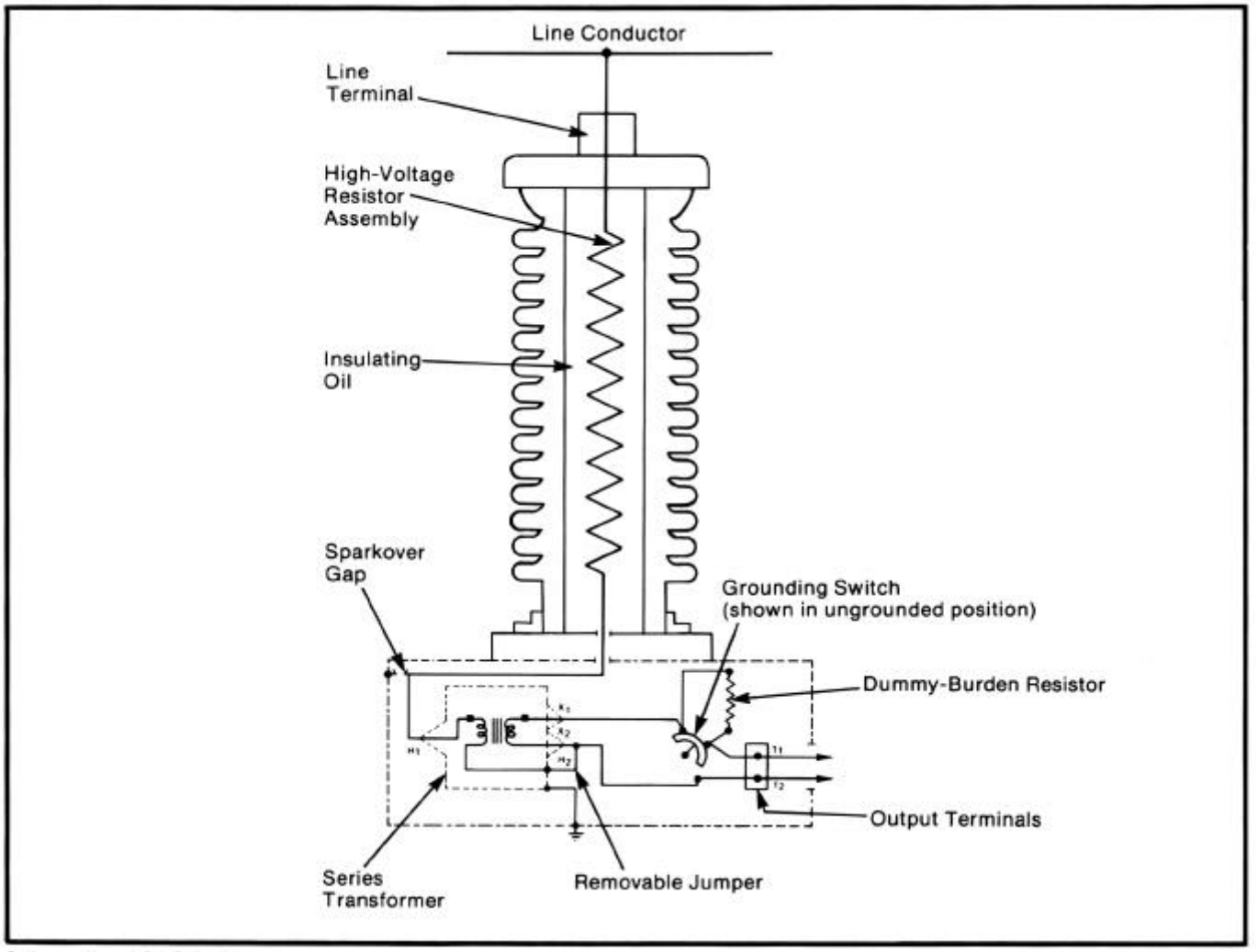
The series transformer is of the single-primary-bushing type, oil filled and solder sealed. A nickel-iron core is used in the transformer of the 15-volt-ampere models to minimize the phase shift between the applied voltage and the output voltage and to improve the linearity of the output. The neutral end of the primary winding is permanently connected to the transformer case, which is grounded. The secondary winding is completely isolated and has a low-frequency withstand to ground of 2.5 kv for one minute. A removable jumper is furnished, connected from the X_2 secondary winding terminal to ground. (The jumper may be removed if single-point grounding at another location is desired.)

The top cover of the device, to which the resistor assembly is internally connected, is provided with a choice of two connector arrangements-a parallel-groove type for use with wire conductors, or a vertical-pad line terminal with standard four-hole drilling for use with bus or pad-terminal connectors.

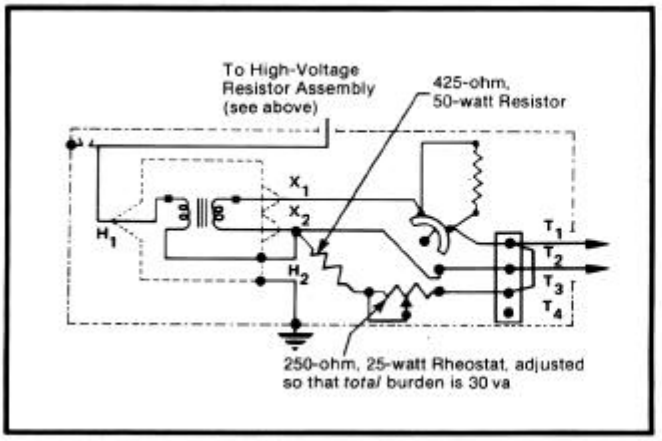
To allow removal of the connected burden without open-circuiting the transformer secondary winding, a hookstick-operated grounding switch is provided in the base of the potential device. The switch, when placed in the "ground" position, short-circuits and grounds the potential-device output terminals and at the same time connects an internal dummy-burden resistor across the secondary winding of the transformer.

‡ *Cypoxy* is the S&C trademark for S&C's cycloaliphatic epoxy resin system.

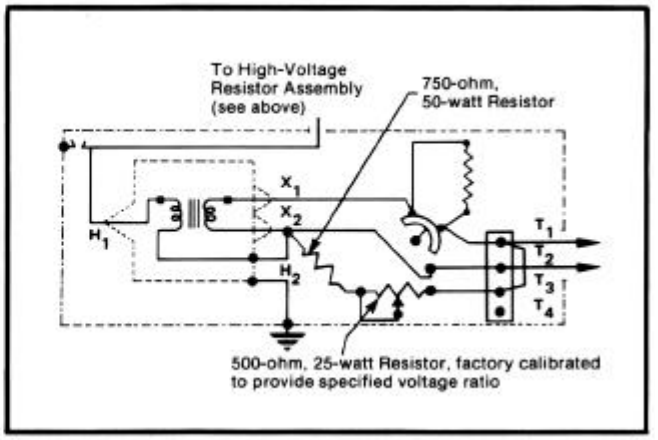
CONSTRUCTION



Schematic of S&C 30-Volt-Ampere Potential Device.

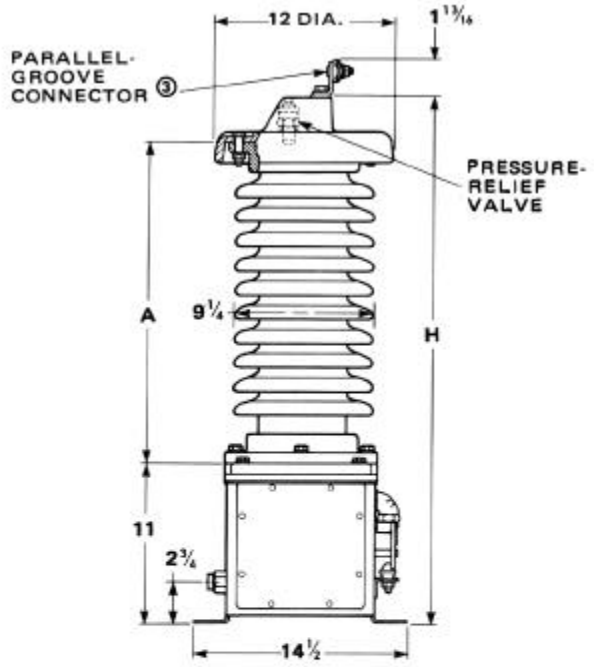


Schematic of S&C 30-Volt-Ampere Potential Device equipped with optional factory-adjusted calibration device, catalog number suffix "-T."

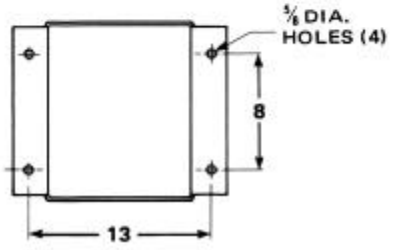


Schematic of S&C 15-Volt-Ampere Potential Device.

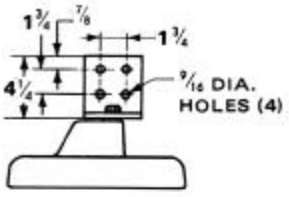
SPECIFICATIONS



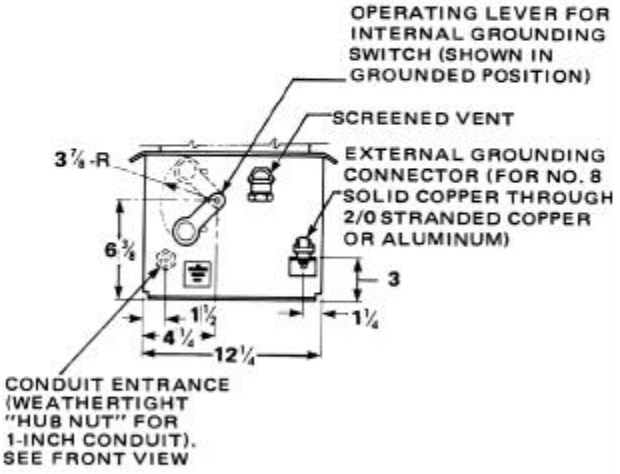
FRONT VIEW



BASE-ENCLOSURE BOLT PLAN



Alternate connector arrangement: vertical-pad line terminal ③



RIGHT-SIDE VIEW

S&C 30-VOLT-AMPERE POTENTIAL DEVICES①

Rating, Kv, Nominal		Applied Line-to-Ground Voltage, Kv①	Resistance of High-Voltage Resistor Assembly, Megohms	Catalog Number③④	Dimensions, Inches		Net Wt., Lbs.
System	Device (BIL)				A	H	
23	150	13.3	1.5	81473R6	18	32	115
34.5	200	19.9	3.0	81344R6	18	32	115
46	250	26.6	4.5	81475R6	28	42	165
69	350	39.8	8.0	81346R6	28	42	165
115	550	66.4	15.0	81478R6	48	62	275
138	650	79.6	17.6	81349R6	48	62	275

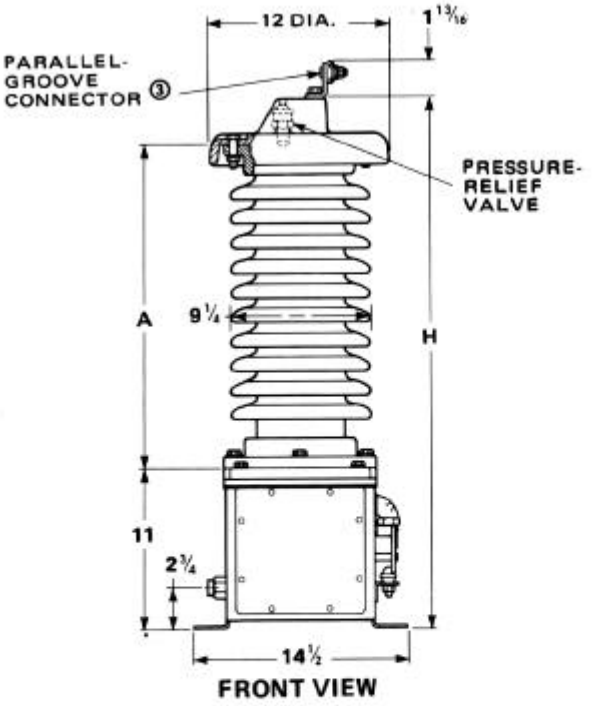
① Applicable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. For neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors, S&C Potential Devices rated 15 volt-amperes are to be used.

② The output voltage of an S&C Potential Device rated 30 volt-amperes is nominally 120 volts rms with a 480-ohm resistive burden connected across the output terminals and with line-to-ground voltage corresponding to rated system voltage applied to the line terminal.

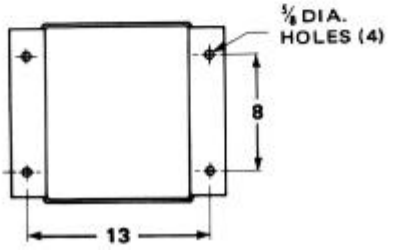
③ To specify a parallel-groove connector accommodating conductors from No. 6 solid copper through No. 2 stranded copper or aluminum in one groove; No. 2 solid copper through 250 kc mil stranded copper or aluminum or 4/0 ACSR in the other groove-add suffix "-D" to the catalog number of the selected potential device. To specify a vertical-pad line terminal with standard four-hole drilling, add suffix "-G" to the catalog number of the selected potential device.

④ S&C Potential Devices rated 30 volt-amperes ordered for use with S&C Automatic Control Device-Type GP or for use with the unbalance compensation module option of S&C Automatic Control Device-Type UP or UPR must be equipped with a factory-adjusted calibration device (contained within the base of the potential device). To order, add suffix "-T" to the catalog number.

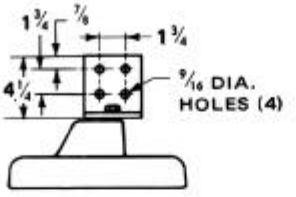
SPECIFICATIONS



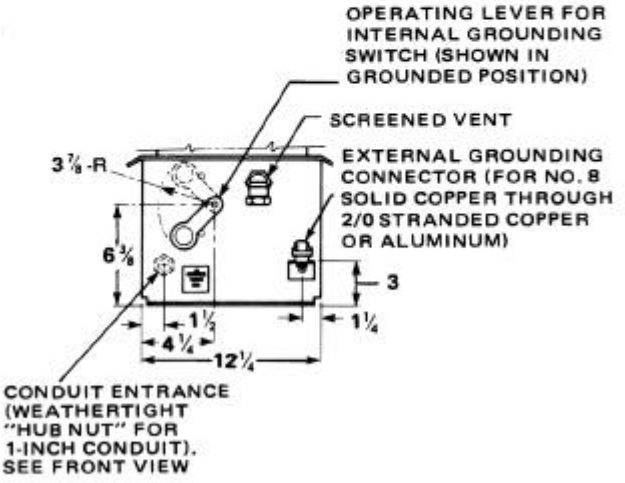
FRONT VIEW



BASE-ENCLOSURE BOLT PLAN



Alternate connector arrangement: vertical-pad line terminal ③



RIGHT-SIDE VIEW

S&C 15-VOLT-AMPERE POTENTIAL DEVICES ①

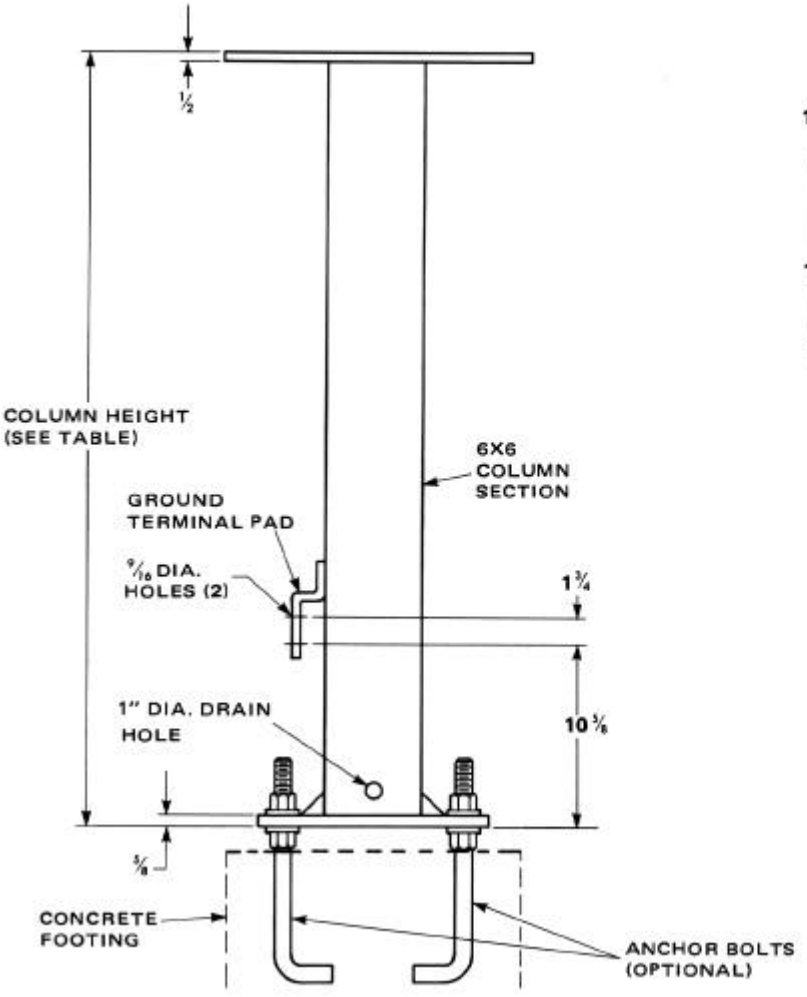
Rating, Kv, Nominal		Voltage Ratio②	Catalog Number①	Dimensions, Inches		Net Wt., Lbs.
System	Device (BIL)			A	H	
23	150	111:1	81573R1	18	32	115
34.5	200	166:1	81574R1	18	32	115
69	350	332:1	81576R1	28	42	165
138	650	664:1	81579R1	48	62	275

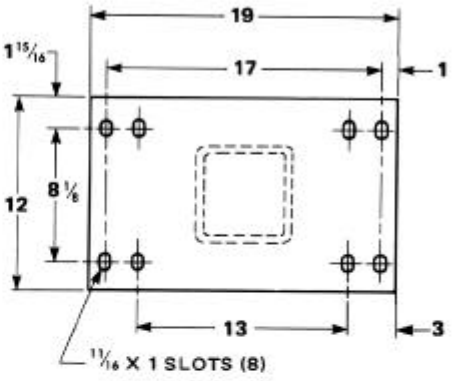
① Applicable only for neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors. For line-to-ground connection, as well as intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, S&C Potential Devices rated 30 volt-amperes are to be used.

② These potential devices include a factory-adjusted burden resistor which provides the specified input-to-output voltage ratio.

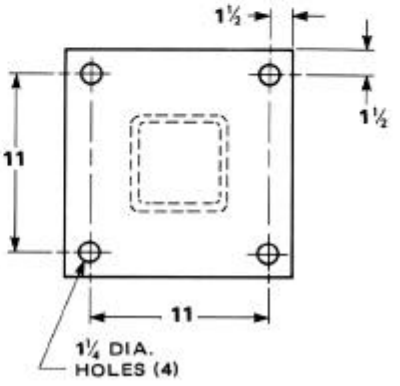
③ To specify a parallel-groove connector accommodating conductors from No. 6 solid copper through No. 2 stranded copper or aluminum in one groove; No. 2 solid copper through 250 kc mil stranded copper or aluminum or 4/0 ACSR in the other groove-add suffix "-D" to the catalog number of the selected potential device. To specify a vertical-pad line terminal with standard four-hole drilling, add suffix "-G" to the catalog number of the selected potential device.

SPECIFICATIONS





TOP PLATE DETAIL



BASE PLATE DETAIL

MOUNTING PEDESTALS

Item	Column Height, Feet ①	Catalog Number	Anchor Bolts, ② Nominal Size and Quantity Required
Mounting Pedestal (one per set), square steel tube construction, galvanized finish	8	92430R1-G	1"X2'-9" 4 Required
	9	92431R1-G	
	10	92432R1-G	
	11	92433R1-G	
	12	92424R1-G	

① Intermediate heights (less than 12 feet) are available in 3-inch increments. Specify by adding one of the following suffixes to the catalog number of the mounting pedestal of nearest lower height:

-S3 Three inches additional height
-S6 Six inches additional height
-S9 Nine inches additional height

Note: Maximum available column height is 12'-0".

② Specify anchor bolts, if desired, by adding suffix "-A" to the catalog number, for example, 92424R1-GA. Note: Each anchor bolt includes a set of two nuts and two washers to facilitate leveling. Nuts, washers, and threaded portion of anchor bolts are furnished galvanized.

Specifications

Conditions of Sale

STANDARD: Seller's standard conditions of sale set forth in Price Sheet 150 apply.

SPECIAL TO THIS PRODUCT:

INCLUSIONS: The S&C Potential Device is a voltage-sensing unit consisting essentially of an oil-insulated high-voltage resistor assembly and a series output transformer, along with a pressure-relief valve for the high-voltage resistor assembly, a protective sparkover gap for the series transformer, and an internal grounding switch with dummy burden.

Models having 15-volt-ampere, 120-volt output, further, have a secondary burden resistor contained within the base of the unit, factory-calibrated to provide the potential device with the applicable voltage ratio listed in the table below. These models are suitable for monitoring neutral-to-ground voltage on ungrounded, wye-connected shunt capacitor banks, for use in conjunction with equipment having high-impedance input circuits, such as the S&C Bankgard™ Relay—Type LUC, and the S&C BankGuard Plus® Control.

S&C Potential Device rated 15-volt-amperes having a system voltage rating as follows:

Nominal Source Voltage, kV	below 23	23	34.5	46	69	115	138	161	230
S&C Potential Device System Voltage Rating, kV, Nom.	23	23	23	23	34.5	69	69	138	138

Models having 30-volt-ampere, 120-volt output do not include a secondary burden resistor. These models are suitable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. When used in conjunction with equipment having high-impedance input circuits, such as the S&C BankGuard Plus® Control, these potential devices must be equipped with a factory-adjusted calibration device (contained within the base of the potential device), Catalog Number Suffix "-T"; see "Optional Features for Potential Devices" table on page 5.

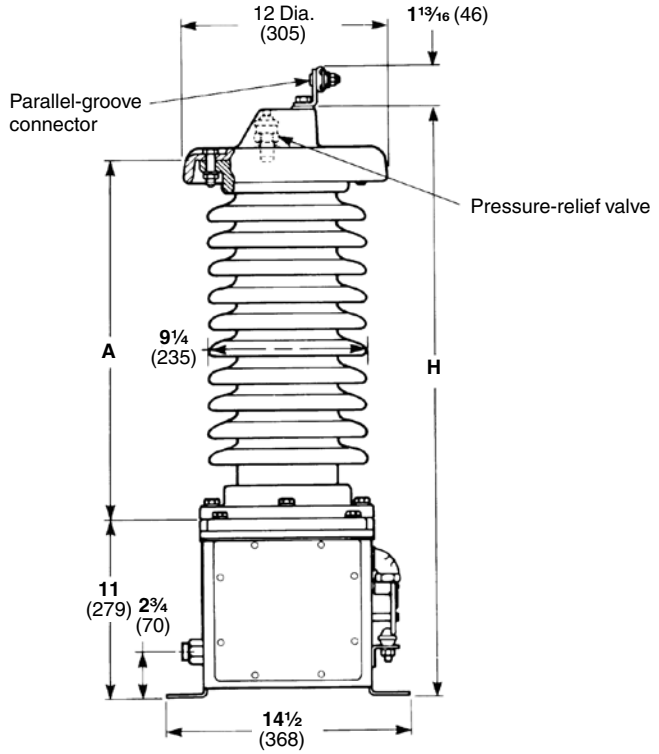
A choice of line terminal arrangements is available; see "Optional Features for Potential Devices" table on page 5.

EXCLUSIONS: Potential devices do not include mounting pedestals. Mounting pedestals are available as listed in this specification bulletin.

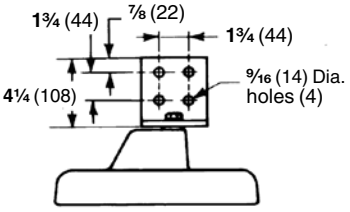
SPECIFICATION NOTE: Potential devices are suitable for upright mounting only. Gray (Munsell Number 5 BG 7.0/0.4) insulators are standard.

Potential Devices—15-Volt-Ampere Output Rating①②

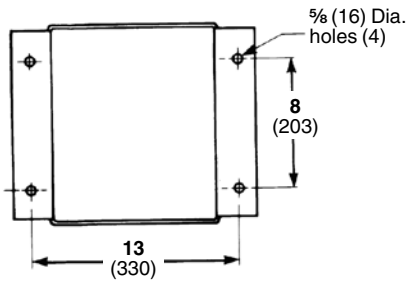
Dimensions in inches (mm)



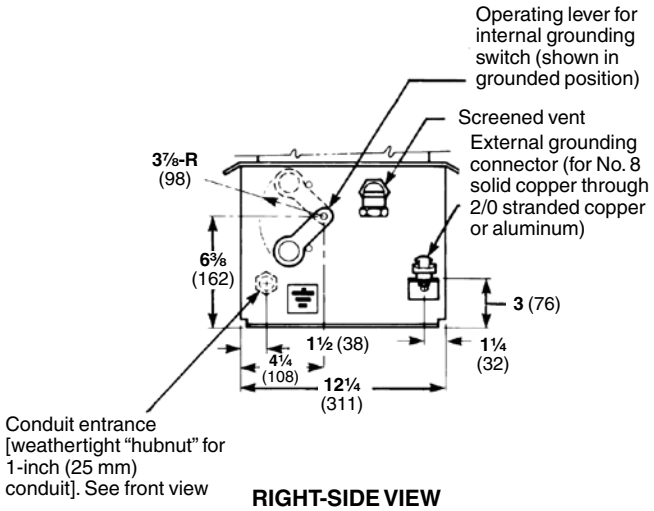
FRONT VIEW



Alternate connector arrangement: vertical-pad line terminal



BASE-ENCLOSURE BOLT PLAN



RIGHT-SIDE VIEW

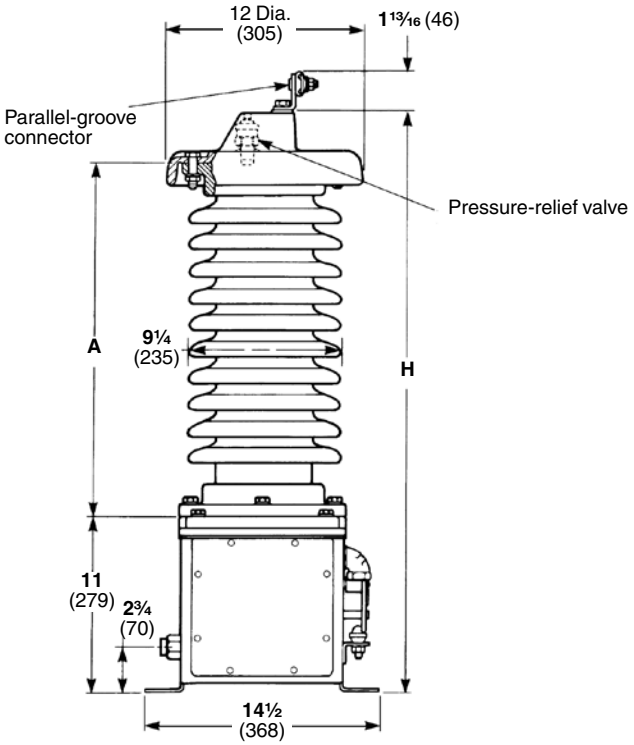
Rating			Catalog Number	Dimensions in Inches (mm)		Net Wt., Lbs. (kg)
kV		Voltage Ratio				
System Voltage, Nom.	Device (BIL)			A	H	
23	150	111:1	81573R1	18 (457)	32 (813)	115 (51.75)
34.5	200	166:1	81574R1	18 (457)	32 (813)	115 (51.75)
69	350	332:1	81576R1	28 (711)	42 (1067)	165 (74.25)
138	650	664:1	81579R1	48 (1219)	62 (1575)	275 (123.75)

① Applicable only for neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors. For line-to-ground connection, as well as intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, S&C Potential Devices rated 30 volt-amperes are to be used.

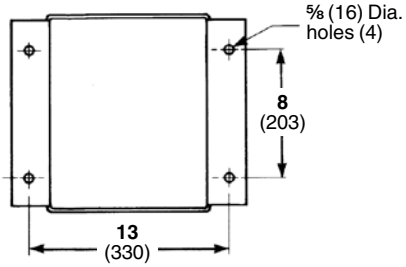
② These potential devices include a factory-adjusted burden resistor which provides the specified input-to-output voltage ratio.

Potential Devices—30-Volt-Ampere Output Rating①②

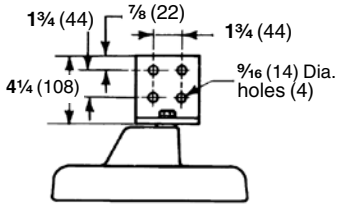
Dimensions in inches (mm)



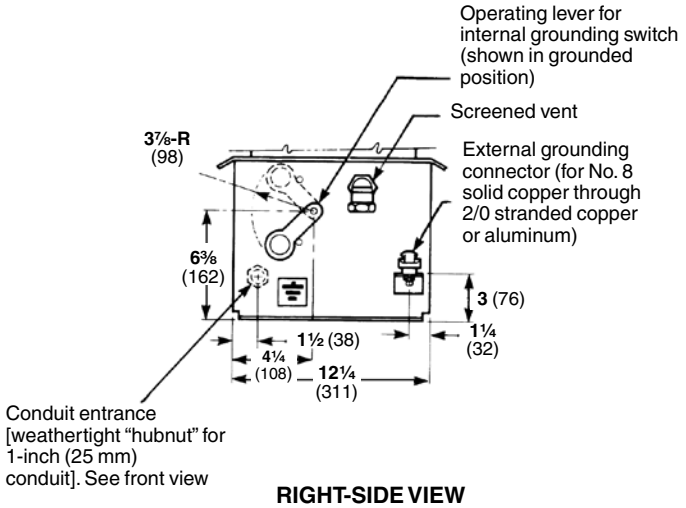
FRONT VIEW



BASE-ENCLOSURE BOLT PLAN



Alternate connector arrangement: vertical-pad line terminal



RIGHT-SIDE VIEW

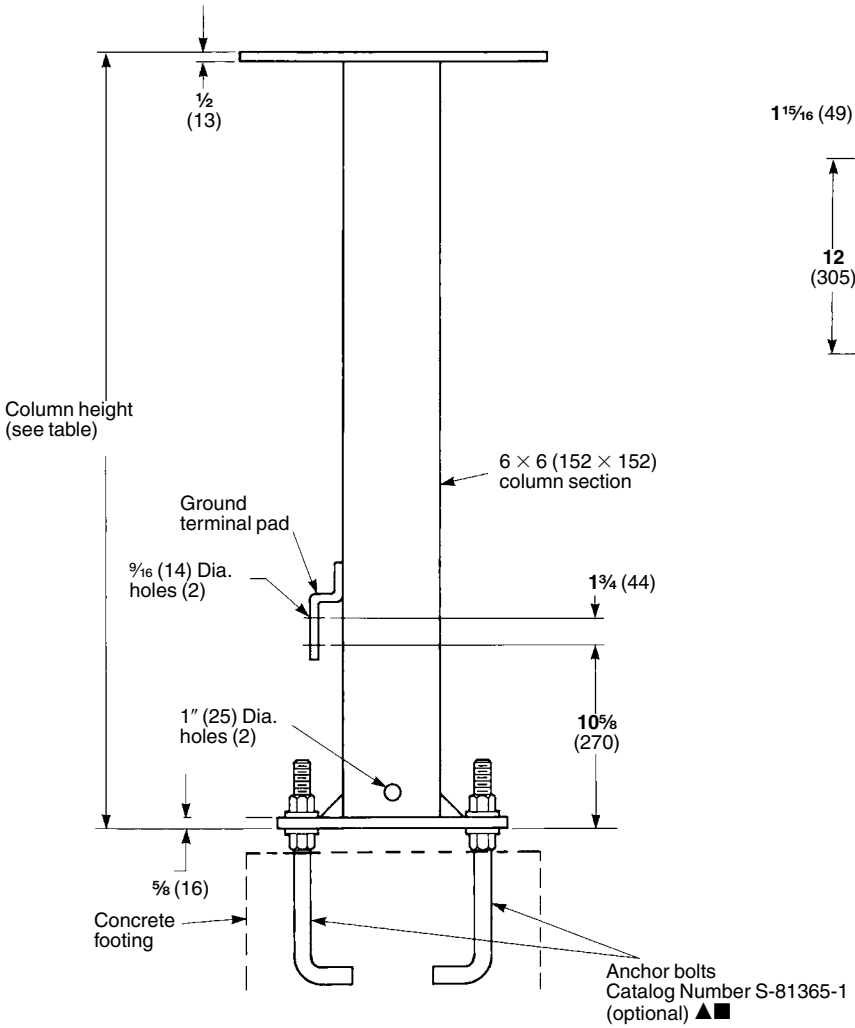
Rating, kV		Applied Line-to-Ground Voltage, kV	Resistance of High-Voltage Resistor Assembly, Megohms	Catalog Number	Dimensions in Inches (mm)		Net Wt., Lbs. (kg)
System Voltage, Nom.	Device (BIL)				A	H	
23	150	13.3	1.5	81473R6	18 (457)	32 (813)	115 (51.75)
34.5	200	19.9	3.0	81344R6	18 (457)	32 (813)	115 (51.75)
46	250	26.6	4.5	81475R6	28 (711)	42 (1067)	165 (74.25)
69	350	39.8	8.0	81346R6	28 (711)	42 (1067)	165 (74.25)
115	550	66.4	15.0	81478R6	48 (1219)	62 (1575)	275 (123.75)
138	650	79.6	17.6	81349R6	48 (1219)	62 (1575)	275 (123.75)

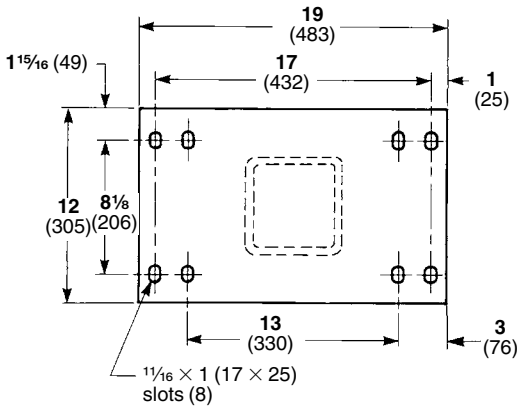
① Applicable for intermediate-tap-point-to-ground connection on grounded, wye-connected shunt capacitor banks, and for line-to-ground connection in all other applications. For neutral-to-ground connection on ungrounded, wye-connected shunt capacitor banks and reactors, S&C Potential Devices rated 15 volt-amperes are to be used.

② The output voltage of an S&C Potential Device rated 30 volt-amperes is nominally 120 volts RMS, with a 480-ohm resistive burden connected across the output terminals and with line-to-ground voltage corresponding to rated system voltage applied to the line terminal.

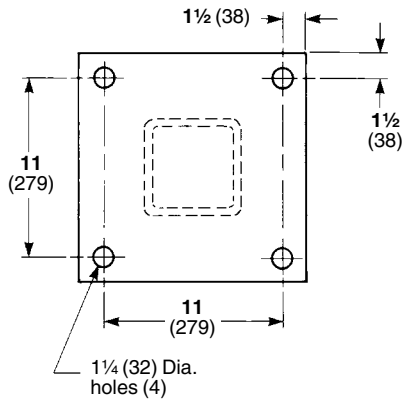
Mounting Pedestals

Dimensions in inches (mm)





TOP PLATE DETAIL



BASE PLATE DETAIL

▲ Each anchor bolt is of galvanized steel and is furnished with two hex nuts and two flat washers to facilitate leveling the mounting pedestals.

■ Nominal size of anchor bolts: 1″× 2′ -9″ (25 mm × 838 mm).

Item	Column Section, Inches (mm)	Column Height, Feet (m)①	Catalog Number
Mounting Pedestal (one per set), square steel tube construction, galvanized finish	6 × 6 (152 × 152)	8 (2.44)	92430R1-G
		9 (2.74)	92431R1-G
		10 (3.05)	92432R1-G
		11 (3.35)	92433R1-G
		12 (3.66)	92424R1-G

① Intermediate heights (less than 12 feet [3658 mm]) are available in 3-inch (76 mm) increments. Specify by adding one of the following suffixes to the catalog number of the mounting pedestal of nearest lower height:

-S3 Three inches (76 mm) additional height
-S6 Six inches (152 mm) additional height
-S9 Nine inches (229 mm) additional height

Note: Maximum available column height is 12′-0″ (3658 mm).

Optional Features for Potential Devices	
Item	**Suffix to be Added to Catalog Number**
Parallel-groove connector①	-D
Vertical-pad line terminal with standard four-hole drilling	-G
Calibration device	-T

① Accommodates conductors from No. 6 through No. 2 stranded copper or aluminum in one groove, No. 2 solid copper through 250 kc mil stranded copper or aluminum or 4/0 ACSR in the other groove.

UNIT DESIGN INFORMATION

RATINGS

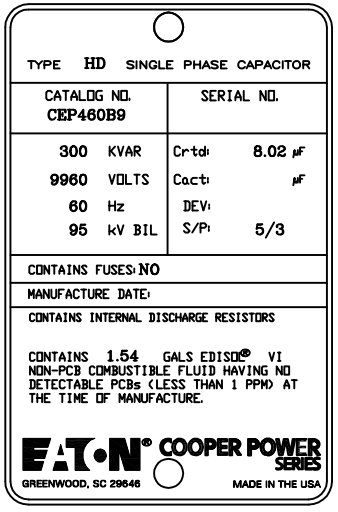
OUTPUT : 300 KVAR
VOLTAGE : 9960 V
FREQUENCY : 60 HZ
CAPACITANCE : 8.02 uF
BIL : 95 kV

PHYSICAL CHARACTERISTICS

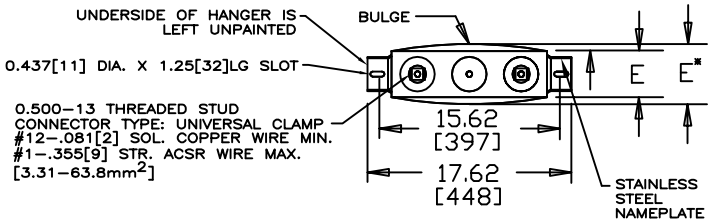
BUSHING 1 CREEPAGE : GROUND STUD
BUSHING 2 CREEPAGE : 12.00" [305 mm]
TANK/BUSHING COLOR : ANSI 70 SKY GRAY
BUSHING TYPE : PORCELAIN
WEIGHT : 63 LBS [28.8 KG]
DIELECTRIC FLUID : 1.55 GALS [5.9 L] EDISOL VI

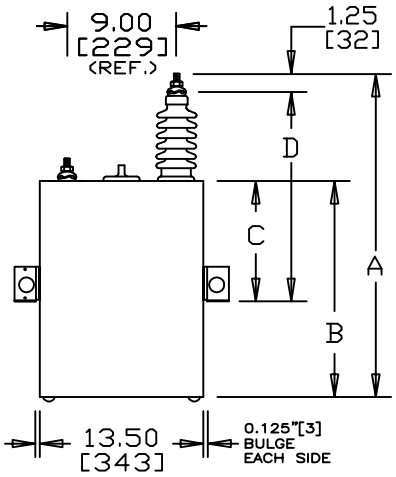
DIMENSIONS

A : 23.13" [588 mm]
B : 14.50" [368 mm]
C : 9.88" [251 mm]
D : 17.26" [438 mm]
E : 5.50" [140 mm]
E* : 6.38" [162 mm]



IEEE NAMEPLATE CCZ56K1
NOTE: MATERIAL-.018 STAINLESS STEEL TYPE 302 18-8.





INTERNAL DESIGN

SERIES SECTIONS : 5
PARALLEL ELEMENTS : 3
CONTAINS INTERNAL DISCHARGE RESISTORS
DOES NOT CONTAIN INTERNAL FUSES

LEGEND = INCHES / [MM]

FINISHED PART TOLERANCES (UNLESS OTHERWISE SPECIFIED) .XX = ±.125 INCHES

REV.	DATE	BY	ECN NO.

DR. CEJ	AP.	FILE NO.	ECN

EATON
Powering Business Worldwide

DESC: COOPER POWER SERIES
TYPE HD SINGLE PHASE CAPACITOR UNIT

DATE:	DWG:	REV:
6/28/2017	CEP460B9	00