

## Externally fused block banks installation instructions



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## 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

## Externally fused block banks installation instructions

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 capacitance of the capacitor unit to ensure it is within its 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.

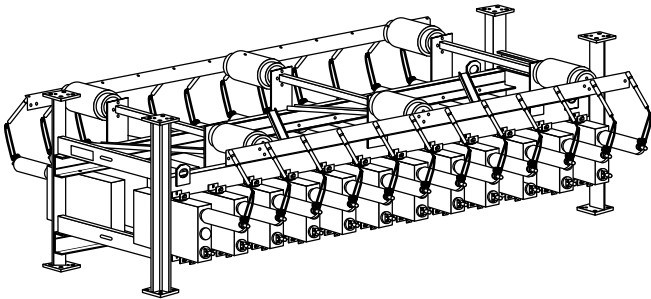


Figure 2. Externally fused capacitor block

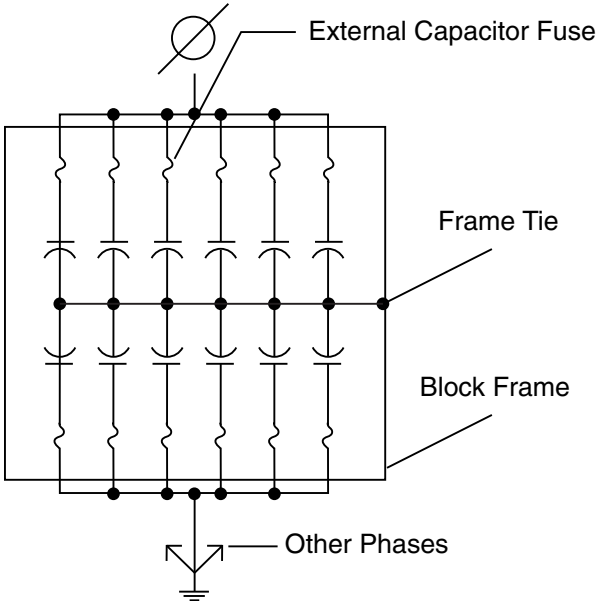


Figure 3. Typical externally fused capacitor bank schematic (One phase)

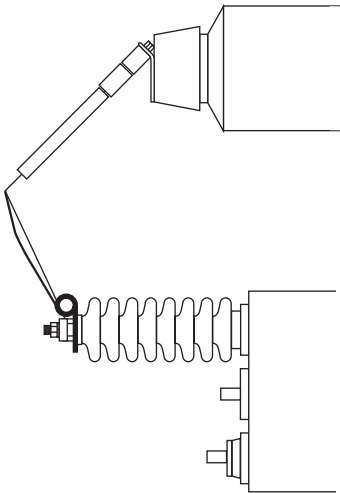


Figure 4. External expulsion fuse

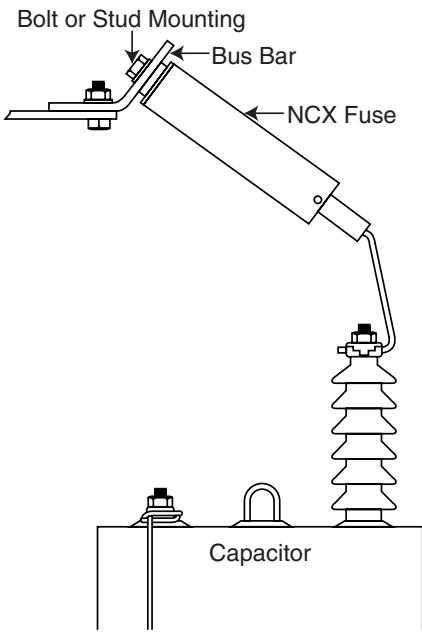


Figure 5. External current limiting fuse

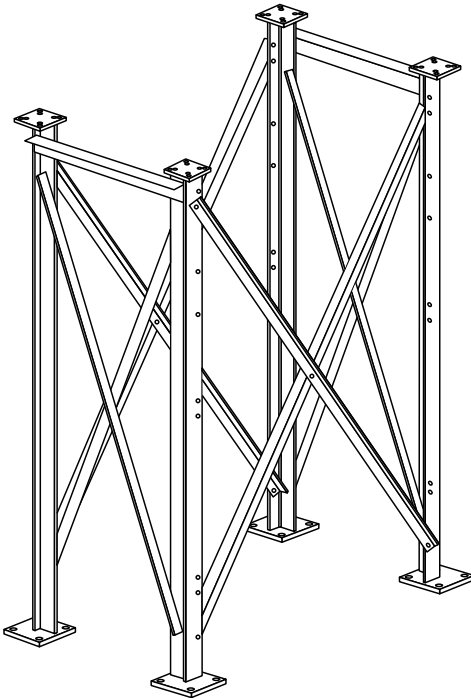


Figure 6. Typical elevating structure

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.

## Externally fused block banks installation instructions

### 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.

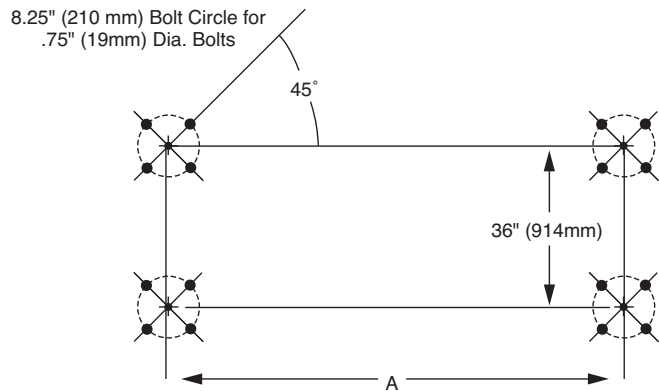


Figure 7. Typical anchor bolt plan

### 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.



## Externally fused block banks installation instructions

### 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<sup>2</sup>t duty to the individual fuses beyond their withstand. In extreme cases, resistance may need to be added in the back-to-back 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.

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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 <sup>1</sup>
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 <sup>2</sup>

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

$\pi$  = 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.

Externally fused block banks installation instructions

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