INSTRUCTIONS
GEM®
Low-voltage Industrial Capacitor Units

GENERAL SAFETY INSTRUCTIONS

The objective of these instructions is to help make capacitor users aware of application and handling practices which will aid them in the use of power capacitors. The guides cover good practices in receiving, handling, installation, fusing, field testing and disposal of power capacitor units. The guides do not address themselves to the requirements of national and/or local codes, nor to requirements of insurance underwriters, which may be applicable to any given capacitor application. Compliance with codes and insurance underwriters' requirements demand individual consideration on the part of capacitor users for each particular situation and should not be assumed to have been achieved simply by complying with the suggestions contained in these instructions.

PROTECTION AGAINST SHOCK

CAUTION: *POWER MUST BE SWITCHED OFF BEFORE DOING ANY WORK ON CAPACITORS OR EQUIPMENTS. TO BE CERTAIN THAT THE CAPACITORS HAVE BEEN DISCONNECTED FROM THE POWER SOURCE, IT IS NECESSARY TO MAKE A VISUAL CHECK FOR AN OPEN-CONTACT DISCONNECT.*

After being disconnected, the capacitors or equipments should then be shorted and grounded as follows:

GEM capacitors have internal discharge resistors (so indicated on the nameplate) which are designed to reduce voltage, after the power is switched off, to 50 volts or less in one minute. After the indicated time, the GEM capacitor or equipment should be shorted and grounded using a suitable insulated grounding stick. Next, the capacitor terminals should be connected together and grounded to the case before handling.

EXPLOSION HAZARD

GEM power capacitors consist of one or more individual capacitor cells. Each cell has an internal pressure-sensitive interrupter to minimize the possibility of case rupture in the event of dielectric failure. Line fuses supplement the individual internal cell interrupter for protection against line-to-ground fault. **Three phase capacitors fused only on two terminals, and single phase capacitors fused only on one terminal, are commonly applied on delta or ungrounded wye systems. An internal ground fault from the unfused phase-to-case could result in case rupture.** This possibility must be considered when locating the capacitors.

HANDLING OF FAILED CAPACITORS

WARNING: *AVOID LIQUID CONTACT WITH THE SKIN AND EYES AND EXPOSURE TO FUMES IN AN UNVENTILATED AREA.*

It is possible that a GEM capacitor cell may be considerably bulged due to internal gassing prior to operation of its internal pressure-sensitive interrupter. This condition can be detected visually by the domed appearance of the cell cover. A cell with such a bulged cover should be carefully handled. If the cell is still hot when the bulged condition is noted, it is recommended that the capacitor be permitted to cool before handling. This will lower the internal pressure, reducing the possibility of case rupture with leakage of gasses and liquid during subsequent handling.

COMBUSTIBLE IMPREGNANT FIRE HAZARD

These capacitors contain a Class III.B combustible liquid which could possible ignite if there is a case puncture or rupture in the presence of an electrical arc. Capacitors should be suitably protected from mechanical damage and located where possible fire would not result in damage or hazard to the surrounding area.

DISPOSAL OF CAPACITORS OR IMPREGNANT

The impregnating liquid used in this capacitor is DIELEKTROL® VI, a biodegradable material. Incineration, or other disposal should be in accordance with Federal, State and Local Regulations.

APPLICATION

GEM capacitor units are designed for service with motors or other inductive loads to improve power factor. They can be located indoors or outdoors.

RECEIVING

Check the capacitor when received to make sure that no damage occurred during shipment. Minor damage such as small dents will not harm the unit's performance, but units with large dents, leaks, or broken bushings should not be installed. See the section on "Maintenance" for the method of handling units with leaks. In case of major damage, file a claim against the carrier and also notify the nearest Sales Office of the General Electric Company for instructions regarding the disposition of the capacitor.

Check the capacitor nameplace to make certain that the capacitor voltage rating is the same as the applied voltage. According to NEMA Standard CP-1 the recommended maximum continuous working voltage to be applied to the capacitor shall not exceed 110 percent of the nameplate rating. The peak continuous working voltage, including all harmonics, shall not exceed 1.1 x $\sqrt{2}$ x the nameplate voltage rating. Any lower voltage is permissable.

INSTALLATION

Capacitors can be installed indoors or outdoors. Capacitors must be mounted in an upright position. Capacitors may be stored in any position. Minimum spacing between large sides of adjacent capacitors should be 4 inches; for ceiling mounting, a minimum of 12 inches should be allowed between the top of the capacitor case and the ceiling.

When capacitors are mounted in hangers, it is recommended that both the capacitor case and the hanger (if it is metal) be grounded to eliminate the minor shock which may be obtained from the small changing current between the line terminals and the case. A terminal is supplied in the connection compartment for grounding purposes.

The continuous current rating of wire used to connect the capacitors should be at least 135 percent of the rated capacitor line current. See Table 1 - Page 4. For single-phase units, this value may be computed from the formula $I = \frac{KVAR}{E} \times 1350$; for three-phase units, it is $I = \frac{KVAR}{E} \times 780$. (E = Rated Voltage).

Terminal posts are provided for line connections. When aluminum conductors are used, especially in a salt or corrosive atmosphere, the slow galvanic action caused by the contact of different metals can be reduced if an oxidation preventative such as Penotrox A (Burndy Co.) or No-ox-id (Dearborn Chemical Co.) is used to coat the aluminum conductor at the point of connection.

Capacitors may be connected directly to the terminals of the motor or other inductive load, or they may be installed singly or in groups and connected through fused switches or circuit breakers to the line.

AMBIENT TEMPERATURE

High operating temperatures will reduce the life of a capacitor. For this reason, the capacitor should be located in an area of unrestricted ventilation and the capacitor should also be mounted away from hot objects or surfaces. Maximum ambient is 46° C (115° F).

Capacitors may operate continuously at any low temperature. However, if the internal temperature of any unenergized capacitor drops to less than -40° C (-40° F), the unit should not be energized. The units then must be brought to at least -40° C for 12 hours before they may be energized without possibility of damage. For this reason, if extremely low temperatures are anticipated, it is advisable to have the capacitors on line to maintain the internal temperature above -40° C.

FUSING

NEC Article 460-8B requires capacitors to have overcurrent protection in all ungrounded conductors (except: if connected on the load side of a motor overload protective device).

Three phase capacitors fused only on two phases will not provide adequate protection if a line-to-ground fault should occur.

MAINTENANCE

Capacitors should be inspected periodically to see that they are operating. If blown fuse indicating lights are available, check to see that they are off while the capacitors are on line. The following additional checks can be made after de-energizing, waiting one minute, removing the cover, then shorting and grounding all terminals.

1. Visually inspect all cells for domed covers. If any are found they should be replaced.

2. If fuses are used without indicating lights, check for continuity.

TESTING

Field tests may be made to evaluate the operating conditions of the capacitor. Such tests are warranted only if trouble is indicated or if the unit has been damaged.

1. Open circuits, internal short circuits, and KVAR capacity can be tested by measuring the current taken by the capacitor when connected to a suitably protected circuit of rated voltage (E) and good wave form. For single phase units

the line current (I) is calculated as $I = \frac{KVAR}{E} \times 1000$. For three phase units: $I = \frac{KVAR}{E} \times 577$. (If 3 phase power is available.

If 3 phase power is **not** available then test as follows:

Connect single phase rated voltage (E) to any two of the three phase terminals and measure current. Repeat with two additional current readings on remaining combinations of terminals. Current (I) should be:

$$I = \frac{KVAR}{E} \times 500$$

Due to capacitance tolerance, 15% over current is acceptable. If the current is low by more than 10%, examine each cell for a bulged cover (activated disconnect). Remove the suspect cell or cells and replace.

2. The insulation between the terminals and case can be tested by applying 1000 VAC from a suitably protected source between the short-circuited terminals and case.

WARRANTY

The following basic information must be provided with respect to warranty claims:

Serial number, date in service, date failed, fixed or switched, conditions at the time of failure. Do not scrap an in-warranty capacitor unless authorized by manufacturer.

TABLE 1. Connection Wire Size

480V Total kVAr	135% 3Ph rated Amps	MIN CU CABLE 90C AWG MCM	600V Total kVAr	135% 3Ph rated Amps	MIN CU CABLE 90C AWG MCM	240V Total kVAr	135% 3Ph rated Amps	MIN CU CABLE 90C AWG MCM
1.0	1.6	14	1.0	1.3	14	1.0	3.2	14
1.5	2.4	14	1.5	1.9	14	1.5	4.9	14
2.0	3.2	14	2.0	2.6	14	2.0	6.5	14
2.5	4.1	14	2.5	3.2	14	2.5	8.1	14
3.0	4.9	14	3.0	3.9	14	3.0	9.7	14
4.0	6.5	14	4.0	5.2	14	4.0	13.0	14
5.0	8.1	14	5.0	6.5	14	5.0	16.2	12
6.0	9.7	14	6.0	7.8	14	6.0	19.5	12
7.5	12.2	14	7.5	9.7	14	7.5	24.4	10
10.0	16.2	12	10.0	13.0	14	10.0	32.5	8
12.5	20.3	10	12.5	16.2	12	12.5	40.6	8
15.0	24.4	10	15.0	19.5	12	15.0	48.7	8
20.0	32.5	8	20.0	26.0	10	20.0	65.0	6
25.0	40.6	8	25.0	32.5	8	25.0	81.2	4
30.0	48.7	8	30.0	39.0	8	30.0	97.4	2
35.0	56.8	6	35.0	45.5	8	35.0	113.7	2
40.0	64.9	6	40.0	52.0	6	40.0	129.9	1
45.0	73.1	4	45.0	58.5	6	45.0	146.1	1/0
50.0	81.2	4	50.0	65.0	6	50.0	162.4	2/0
60.0	97.4	2	60.0	77.9	4	60.0	194.9	4/0
70.0	113.7	2	70.0	90.9	2	70.0	227.3	4/0
75.0	121.8	1	75.0	97.4	2	75.0	243.6	250
80.0	129.9	1	80.0	103.9	2	80.0	259.8	250
90.0	146.1	1/0	90.0	116.9	2	90.0	292.3	2-1/0
100.0	162.4	2/0	100.0	129.9	1	100.0	324.8	2-2/0
125.0	203.0	4/0	125.0	162.4	2/0	125.0	405.9	2-4/0
150.0	243.6	250	150.0	194.9	4/0	150.0	487.1	2-250
175.0	284.2	350	175.0	227.3	4/0	175.0	568.3	2-350
200.0	324.8	400	200.0	259.8	2-1	200.0	649.5	2-400
250.0	405.9	2-4/0	250.0	324.8	2-2/0			
300.0	487.1	2-250	300.0	389.7	2-4/0			
350.0	568.3	2-350						
400.0	649.5	2-400						
450.0	730.7	2-500						
500.0	811.9	2-600						

Wire size based on NEC 1987 TABLE 310-16 adjusted for 40 C ambient.

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