INSTRUCTIONS

Protective Capacitors for AC Rotating Machines

Model 9L18

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

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:

Capacitors for shunt or series application on power systems have internal discharge resistors (so indicated on the nameplate) which are designed to reduce the voltage, after the power is switched off, to 50 volts or less in **ten minutes** if an underground or submersible type, in **five minutes** for all others rated over 600 volts, and in **one minute** for all others rated 600 volts or less. After the indicated time, the capacitor or equipment should be shorted and grounded by utilizing an insulated grounding stick or equivalent and then the capacitor terminals should be connected together and to the case and grounded before handling.

Other types of capacitor units such as dc energy storage, dc filter and pulse forming applications, and certain types of induction heating capacitor units do **not** have internal resistors. With these types of units, the disconnecting, shorting and grounding procedures indicated above must be followed and should be accomplished by utilizing an **external discharge resistor** of **at least** the resistance in ohms equal to the maximum charge voltage that may have been on the capacitor. The shorting connection between terminals should be left on until the unit is reconnected in the circuit.

EXPLOSION HAZARD

The correct application of capacitor fuses will greatly minimize the possibility of case rupture; but since considerable stored energy may be available upon the occurrence of a fault inside a capacitor, it is possible to get explosive case rupture in any application, even with proper fusing. For three-phase capacitors fused only on two terminals, or single-phase two-bushing units fused on only one terminal, and applied on delta or ungrounded wye systems, an internal ground fault from the unfused phase to case might result in case rupture. These remote possibilities must be considered when locating the capacitors or equipments.

If capacitors or equipments are not supplied with fuses, follow the fusing guides recommended in NEMA Standard CP-1; ANSI Standard C-55.1; the General Electric Handbook Section 6212; or refer to the nearest General Electric Sales Office.

HANDLING OF FAILED CAPACITORS

Some failed capacitors may be found considerably bulged due to internal pressure from gassing prior to circuit clearing. Such units should be handled very carefully. A failed capacitor should be shorted with suitable insulated shorting sticks, to discharge any residual charge. It is further recommended that a bulged 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.

In handling capacitors which have liquid leaking out, avoid contact with the skin, and prevent entry into sensitive areas such as the eyes. Close-fitting protective goggles should be worn when handling units which are leaking or might suddenly squirt impregnant while being handled. Contact with the skin is taken care of by simply washing off thoroughly with soap and water as soon as possible. However, the eyes can be quite irritated by some impregnants, so they should be flushed with large amounts of water as soon as possible and then examined by a physician.

COMBUSTIBLE IMPREGNANT FIRE HAZARD

These capacitors contain a Class III.B combustible liquid which could possibly 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 dielectric liquid has been formulated to be environmentally compatible. Good practice demands that the liquid be handled in a manner appropriate for the handling of hazardous chemical liquids, and that loss of the liquid into the environment should be avoided or minimized. The preferred method of liquid disposal is by incineration. If feasible, the solid portion of the capacitor, the roll pack, should also be incinerated and the capacitor case should be disposed of in a waste disposal site approved for hazardous industrial waste.

An alternate method of disposal to be considered is the incineration of the liquid and the disposal of the solid remainder, consisting of the roll pack and the capacitor case, in a waste disposal site approved for hazardous industrial waste.

Disposal of the whole capacitor, including the liquid in a site approved for hazardous industrial waste is a third method which may be considered for the disposal of the power capacitors.

APPLICATION

The General Electric protective capacitor is designed to operate in conjunction with lightning arresters to provide surge protection for a-c rotating machines. It does this by reducing the steepness of the wave front of the voltage surge, thereby reducing the stress on the turn and line-to-ground insulation. The unit consists of a *Dielektrol impregnated capacitor and associated discharge resistor, enclosed in a metal case suitable for indoor or outdoor service. The voltage, capacitance, number of poles, and frequency are shown on the nameplate.

Capacitors for application on circuits having maximum line-to-line voltage up 13800 volts may be either three-phase or single-phase units. Those for application on circuits having maximum line-to-line voltage greater than 13800 volts are single-phase units. The most common connections for these capacitors are shown in Figs. 1 and 2. For applications not shown, contact the nearest General Electric Sales Office.

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.

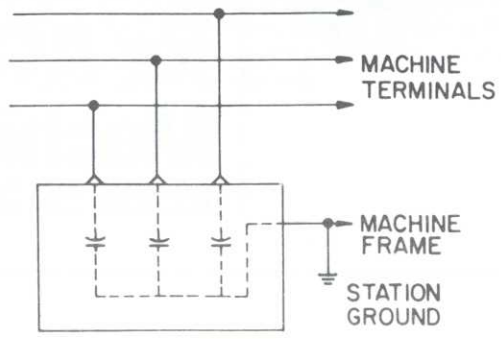

Fig. 1. Three-phase circuit, grounded or ungrounded neutral. Connect each capacitor line terminal separately to each line conductor. Capacitor ground terminal should be connected to station ground and machine frame.

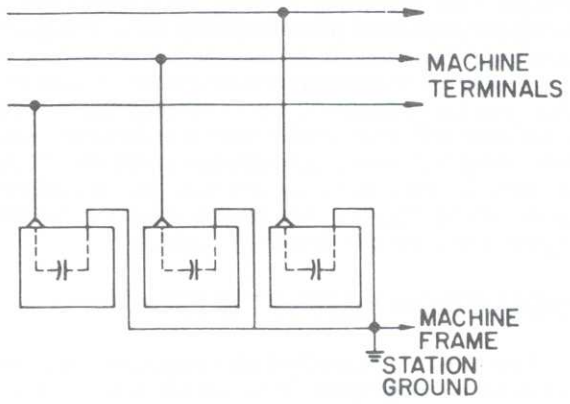

Fig. 2. Three-phase circuit, grounded or ungrounded neutral using single-phase units. Connect line terminal of capacitor to line conductor so that one capacitor is connected to each phase conductor. Each of the capacitor ground terminals should be connected to station ground and machine frame.

The nameplate should be checked to make certain that the rated circuit voltage and frequency on which the capacitor is to be applied do not exceed the capacitor rating. According to NEMA Standard CP-1 the recommended maximum continuous-working voltage to be applied to the capacitor shall be 110 percent of the nameplate rating. The peak continuous working voltage, including all harmonics, shall be $1.1 \times \sqrt{2} \times$ the nameplate voltage rating. Any lower voltage is permissible.

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These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

INSTALLATION

Capacitors may be installed indoors or outdoors. The capacitor should be located as close as possible to the machine to be protected. Connections are to be made from line-to-ground (See Figs. 1 and 2) with the line connection being made on the load side of the breaker, so that in the event of a capacitor failure a bus short-circuit would not result. To obtain the maximum effectiveness from the capacitor in limiting impulse voltages, it is imperative that a low-resistance and low-inductance ground connection be made. The size of the conductor used to ground the capacitor should be at least equivalent to No. 6 AWG. The capacitor ground should be connected to the metal mounting racks or hold-down clamps, the frame of the machine to be protected, the common station ground, the lightning arrester ground, and to the overhead ground wire if used.

Fuses in series with protective capacitors are not recommended, but if such devices are preferred by the purchaser those of the non-inductive type having a resistance of not more than 0.1 ohm and ample short-circuit interrupting capacity should be used. The fuse should have a rating of not less than twenty amperes.

The connectors are plated to keep corrosion to a minimum. However, 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 avoided 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.

When tightening the terminal nut, it is necessary only to flatten the Belleville washers. This provides visual indication of sufficient tightening and results in follow-up pressure on the conductors of approximately 1000 pounds. Tightening to more than 25 foot-pounds is not required or recommended.

TEMPERATURE LIMITATIONS

These capacitors are designed to operate satisfactorily in an ambient temperature of 55 C (131 F) maximum under normal conditions of non-restricted ventilation, provided they are installed on solidly grounded neutral circuits or on non-grounded circuits which have positive provision for tripping on ground faults of one hour duration or less. The maximum allowable ambient temperature for installation on non-grounded circuits which may be subject to grounding of one line for periods in excess of one hour is 40 C (+104 F). Capacitors should not be installed adjacent to any hot radiating surfaces or bodies, unless the ambient temperature is reduced.

Capacitors may operate continuously at any low temperature. However, if the internal temperature of an unenergized capacitor drops to less than −40 C (−40 F), the unit should not be energized. The unit then must be brought to at least −14 C (7 F) before it may be energized without possibility of damage. For this reason, if extremely low temperatures are anticipated, it is advisable to switch capacitors onto the line to keep their internal temperature above the critical point.

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. Evidence of open or internal short circuits as well as the approximate capacity of a protective capacitor may be determined by measuring the current taken when voltage is applied between each pole and ground terminal. The equipment required in making this test includes: (a) a source of rated voltage and frequency having good waveform and with sufficient current available for the capacitor being tested; (b) a suitable switching device, fuse or circuit breaker; and (c) an ammeter provided with short-circuiting switch. A short-circuited capacitor will be indicated by an immediate blowing of a fuse or operation of the protective device when the circuit is closed. An open-circuited capacitor will be indicated by a zero reading on the ammeter with its short-circuiting switch open. A normal current reading will indicate that the capacitor is in satisfactory condition. Allowances should be made for capacitance tolerances of minus zero, plus twenty percent in calculating the normal current. The effect of the discharge resistors may be neglected.

Data on abnormally high or low currents and other irregularities, as determined by the above tests, should be referred to the nearest Sales Office of the General Electric Company for specific recommendations.

When insulation resistance tests are made on apparatus protected by capacitors, the capacitors should be disconnected from the circuit. This will assure that the resistance values being measured will not be influenced by the discharge resistors provided in the protective capacitors.

MAINTENANCE

Under normal service conditions, once a capacitor is installed no further maintenance is required during the life of the unit. Repainting of the units may be desired for appearance, and periodic cleaning of the bushings may be necessary in contaminated atmospheres to prevent arc-over.

Capacitors may be inspected periodically to see that they are operating. If indicating protective devices are not used, the capacitor can be checked most easily by de-energizing (reference Protection Against Shock) and immediately feeling the case side. An operating unit will be warm.

If a leak occurs in the capacitor, the hole should be sealed with solder, using alcohol-rosin flux. When this is impossible or if a bushing is broken, or if a large quantity of liquid impregnant is lost, cover the hole to prevent the entrance of dirt and further loss of liquid. The possibility of factory repair is dependent upon the extent of the damage; therefore, contact the nearest GE Sales Office for recommendations regarding disposition.

Units with large dents may be checked for operation as described under "Testing." If such testing is impossible or if results are unsatisfactory, contact the nearest GE Sales Office regarding the possibility of factory test and repair.

WARRANTY

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

Serial number, date in service, date failed, type of installation (i.e., pole type, stack rack), fixed or switched, conditions at the time of failure. Do not scrap an in-warranty capacitor unless authorized by manufacturer.

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