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INSTRUCTIONS FOR HIGH VOLTAGE POWER CAPACITORS

SAFETY

These instructions are a guide to the safe use of high voltage power capacitors. They do not supplant or take the place of any applicable national and/or local codes, or requirements of insurance underwriters.

Shock Hazard

Before inspecting or working on capacitors, power must be removed from the capacitors by a visible disconnect. After disconnecting the power, the capacitors will generally be left with a charge which must be removed before handling. The charge may be removed by the following:

1. Most power capacitors have internal discharge resistors which will reduce the voltage after the capacitors are disconnected from the power source from rated voltage to 75 volts in 10 minutes or less (discharge resistors to discharge to 50V in 5 minutes on demand).
2. After disconnecting the capacitors power source, wait at least 10 minutes, then short and ground the capacitor equipment and individual capacitors using an insulated grounding stick. Shorting should be terminal to terminal and terminal to case.
3. Individual units should be shorted because equipment shorting is ineffective in case of a fuse operation or other disconnection of a capacitor.

Units which do not or may not contain discharge resistors should be discharged as above except shorting should be accomplished using an external discharge resistor. The resistance in ohms should be about equal to the maximum peak voltage that may have been on the capacitor. The resistor should have a peak voltage capability greater than the maximum peak voltage which may be on the capacitor and an energy absorbing capability greater than the energy stored in the capacitors.
After discharging, a shorting connection should be installed between terminals and removed just prior to re-energization.

Explosion Hazard

The correct application of capacitor protection will greatly minimise the possibility of case rupture; but since considerable stored energy maybe available upon fault inside capacitor, it is possible to get explosive case rupture in any application, even with proper protection.

This remote possibility must be considered when choosing a location for the capacitors or equipment.

Explosion is also a possibility when high voltage tests are performed on a capacitor, and personnel should be protected during these tests.
Some capacitors which fail may bulge considerably due to internal pressure from gassing, but may not rupture. It is recommended that this pressure be relieved before handling by breaking off a bushing terminal with a long pole, or by puncturing the case with a punch after covering the capacitor

with a heavy cloth. This puncture should be made where a minimum of fluid leakage will occur.

Provision for collecting drained fluid should be made before puncturing.

NOTE: Avoid liquid contact with the skin and eyes and exposure to fumes in an unventilated area.

Fire Hazard

Even capacitors contain impregnating liquid which is not classified as combustible according to Material Safety Data Sheet, they could possibly ignite if there is a case rupture in the presence of an electrical arc.
This should be considered when choosing the location of capacitors or equipment. See also local regulations for location limitations.

RECEIVING

When unpacked, carefully inspect the unit for damage and check the nameplate to be sure the desired rating has been received. File a claim immediately with the carrier for any damages sustained in transit.

INSTALLATION

Rating

The maximum continuous operating voltage is 110% of the nameplate rating. When installing capacitors, check the nameplate of each unit to see that it has the proper rating for the circuit.

Mounting

Capacitor units are intended to be mounted individually or in groups. Capacitors for outdoor mounting require no additional protection from the weather under ordinary service conditions. When installing capacitors in racks or hangers, care should be taken to obtain the necessary spacing and electrical clearances. The minimum spacing between large sizes is 55 millimetres. Capacitors are designed for vertical or horizontal mounting at the narrow side.

Bushings and Connections

All current-carrying connections shall be as flexible as possible and feature an adequate cross-sectional area.
The parallel groove connectors accommodate any combination of 2 conductors from 4mm^2 solid to 50mm^2 stranded wire. When aluminium wire is used, an oxidation preventative should be used, especially in a salt or corrosive atmosphere. The connections shall be safe against coming loose.

Torque of more than 25 Nm are not necessary or recommended. Torque on the bushing stud in excess of this value may result in bushing damage and/or personal injury.

Capacitors should not be lifted by the bushings. Lifting by the bushings may cause the capacitor to leak, result in damage to the bushing, and/or cause personal injury.

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Protection and Fusing

A capacitor installation should be protected with unbalance relaying and other devices to remove a capacitor or equipment from the line in the event of a capacitor failure. The protection should be selected to avoid nuisance interruptions but still maintain a low probability of case rupture.

See the technical report IEC 60871-3 for guidance.

Lightning Arresters and Grounding

The capacitor installation should be protected by appropriate lightning arresters located as close as possible to the capacitor. The capacitor mounting frame and arrester ground terminal should be solidly grounded. The capacitor unit grounding is provided by unpainted mounting surface of mounting brackets.

Ambient Temperature

Ambient air temperature category of capacitor is stated on the nameplate. Standard operating/energizing ambient temperatures range for power capacitors according to IEC 60871-1 are listed in the tables below.

Upper temperature category limit	**A**	**B**	**C**	**D**
Maximum (°C)	40	45	50	55
Highest mean over 24 h (°C)	30	35	40	45
Highest mean over 1 year (°C)	20	25	30	35
Low temperature limit during operation	**- 25°C, - 40°C**			

Upper temperature category limit is the ambient temperature limit of the capacitor, as measured at the capacitor. For some applications, such as stacked racks or enclosed equipment, ambient temperatures at the capacitor units will exceed ambient temperature around equipment. Locate capacitors to minimize heating from other equipment, and provide free flow of air around the capacitors. Higher ambient temperatures will shorten the life of a capacitor. The manufacturer's liability does not apply to capacitors failing because the permissible ambient temperature has been exceeded.

Energizing a capacitor with an internal temperature less than **low temperature limit** may damage the capacitor and possibly cause failure. Capacitors should therefore not be energized with internal temperature lower than -25°C or -40°C respectively.

Overloads

Admissible voltage levels and maximum permissible currents are indicated in IEC60871-1.
Switching overvoltages - the residual voltage on a capacitor prior to energization shall not exceed 10 % of the rated voltage.
Transient overcurrents due to the switching should be reduced to acceptable values in relation to the capacitors and to equipment, if necessary, by switching the capacitors through a resistors or by insertion of reactors into the supply circuit to each section of the bank. It is especially important when a section of capacitor bank is switched in parallel with other sections which are already energized.

Note: The above is also extremely important, when replacing the old paper or paper/film capacitors by all-film capacitors. New low-loss capacitors have much smaller impedances (lower ohmic resistance and inductance). Mixing of capacitors made in different technologies should also be avoided in the same bank.

See IEC 60871-1 & 3 for guidance.

MAINTENANCE

A capacitor is basically maintenance-free, requiring only periodic bushing cleaning in contaminated areas and retightening of terminal bushing connections. Equipment should be inspected periodically for failed capacitors or elements. This check can be made (after de-energizing and following "Safety Instructions, Shock Hazard" in the first part of these instructions) by (1) checking for fuse operation indication; (2) checking capacitance of individual units, and/or (3) feeling the capacitor case (a capacitor which has been operating will be warmer than the ambient temperature).

Maintenance plan	**Period**
Capacitance check	Once per 2 years
Retightening connections	Once per 2 years
Bushing cleaning	Once per 2 years

Leaks due to mechanical damage of the case: Please, contact factory or the nearest Iskra Representative.

Testing

Field tests to evaluate the operating condition of capacitors should only be performed if trouble is indicated or if a capacitor has been damaged. Field testing is described in NEMA Standard Publication CP1-2000 (or latest issue).

DISPOSAL OF CAPACITORS OR IMPREGNANT

The dielectric liquid used in this capacitor is 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.

Note: Incineration or other disposal should be in accordance with federal, state, and local regulations.