SALVAGING FLOOD DAMAGED ELECTRICAL EQUIPMENT

Overview

In all drying out of electrical windings, the regulation of temperature should be controlled carefully. Maximum drying temperatures on windings should not exceed 194ºF (90ºC) as measured by thermometer. This will prevent not only the rapid thermal deterioration of the insulation but damage from the high vapor pressures that would be obtained if steam were produced.

Several methods are available for drying equipment. Probably the most satisfactory solution to the problem is when the windings can be placed in an oven with suitable temperature control and proper air circulation. Banks of infrared lamps may be used when this is not possible, or a suitable housing may be built around the machine, using steam coils or electric resistance type units for a source of heat. Openings should be provided for the free circulation of air. Blowers may be used to increase the air movement. Vacuum drying has been also effectively used to expedite the return of equipment to service. Certain precautions are necessary if this method is used, and it should be carried out only by experienced personnel.

Another method often used is to circulate low-voltage current through the windings. This should not be done, however, until the insulation resistance has reached a value of at least 100,000 ohms. Welding sets may be used to provide the current. The flow should be limited to only a fraction of nameplate amperes, and a careful check must be maintained on maximum temperatures on the insulated parts.

On ac generators, drying current may be provided by driving the units at less than rated speed with the terminals short-circuited and excited with very low values of field current. Here again, this should be done only by those with experience in such methods.

During drying operations, when insulation resistance values are used as an indicator of the suitability of windings for service or for application of test potential, the drying must be continued for a sufficient time to make sure that the values are reliable. Often the resistance curve will take one or more sharp dips before leveling off or continuing to increase in a positive direction. This is due to moisture working out of the windings. When the machine is completely dried out, further work is required to remove any remaining dust. This may be done through the use of dry compressed air at pressure not exceeding 40 psi.

With respect to particular classes of electrical equipment damaged by flooding, the procedures listed below should be followed.

Rotating Electrical Machines

1. Completely dismantle all parts.
2. To remove silt or dirt, wash all parts of the machine — except ball or roller bearings, but including windings — with clean, fresh water or stem clean them. Follow this with a thorough cleaning, using a suitable grease solvent. Many such cleaners are toxic, and the necessary safety precautions should be taken.

3. Thoroughly clean all bearings and housings, paying particular attention to oil grooves and oil reservoirs, which may collect silt and dirt. Disconnect and swab any oil lines, or stem clean and dry them.
4. Dismantle brush rigging and clean insulators. Some insulators will retain water, and must be dried thoroughly.
5. Do not apply any voltage to a winding until an insulation resistance reading of at least 100,000 ohms is obtained for several hours, and then only a very low voltage should be used. If windings are very wet, even the low voltage of hand-cranked ohmmeters can puncture the insulation. To avoid this, the crank should be turned at low speeds until some knowledge of insulation resistance value is obtained.
6. Commutators can be difficult to dry out. It may be necessary to loosen or even remove some of the V-ring bolts or clamping nuts in order to let the water out from the inside of the commutator. On large commutators it may be necessary to increase the drying temperature to as high as 266ºF (130ºC), if lower temperatures do not produce satisfactory results after a reasonable period.
7. Bands on armatures or rotors should be checked carefully for tightness. For some applications, they will have to be replaced because of looseness resulting from drying out of insulation underneath.
8. Some slot wedge materials will be affected by moisture. All wedges should be carefully examined and new wedges installed where necessary.
9. DC motor or generator field coils and field coils from synchronous machines sometimes present problems. It may be necessary to remove these coils from the machines for proper treatment if it is found that it is impossible to bring up the insulation resistance otherwise. After a thorough drying in a suitable oven, they should be immersed completely in insulating varnish while hot, and allowed to cool while still immersed. This will tend to draw the varnish into the inside layers. When cooled, the coils should be checked for short circuits by making a comparative test of their resistance, using a bridge or suitable voltmeter and ammeter to measure the voltage drops across each.
10. After a thorough cleaning and drying, most windings should be treated with insulating varnish, particularly if cleaning solvents have removed any of the varnish coatings. Dipping and baking-type varnish, followed by a suitable baking period, is preferable, but air-drying varnish may be used to expedite the return or equipment to service, but only if the original varnish is in reasonably good condition.
11. Before any machine is started, check the entire installation, paying particular attention to lubrication and electrical connections. Determine that no tools or materials have been left in or on the machine.

Switchboards and Electrical Controls

1. Thoroughly clean and dry out all control equipment, dismantling where necessary. Operating coils should be thoroughly dried and dipped in insulating varnish and baked or given one or more coats of air-drying insulating varnish. Check all contacts. Be sure moving parts operate freely.

2. Oil pans on starters and oil switches must be cleaned, dried out, and refilled with oil of proper dielectric strength. Insulating barriers should be dried out or replaced if badly warped.
3. Meters and relays usually will have to be reconditioned at either the manufacturer's service shop or factory. In many instances, it will be cheaper to replace them.
4. All bus insulators and control wiring on switchboards should be cleaned and dried thoroughly. Normally, an insulation resistance of at least one megohm per 1,000 volts operating potential, with a minimum of one megohm, should be obtained before energizing.

Transformers

1. Remove covers or inspection cover plates. Note the condition of the oil and windings, and check for signs of failure. Inspect all connections for looseness or indications of heating. Draw oil samples from top and bottom. Breakdown strength should be at least 22 kV (25 kV if an askarel such as Inerteen, Pyranol, or Chlorextol is used).
2. Check the insulation resistance. The value should be at least one megohm for each 1,000 volts rating, with a minimum of one megohm. Note the condition of bushings, external connections, operating switches, and protective devices. Clean externally and paint the tank if necessary.
3. If water has entered the tank, remove its cover. Flush the windings and core with clean, moisture-free insulating oil. If the transformer is small, remove the coil and core, and dry in an oven at a temperature not over 194ºF (90ºC). Dip and bake the windings whenever the need is clearly evident. Larger units may be dried in the tanks: by forcing hot, dry air at not over 194ºF (90ºC) in and around the windings after the oil has been removed from the tank; by short-circuiting one winding and energizing the other with low ac voltage; or by a combination of these two methods. Insulation resistance checks will determine the progress of drying. A curve should be plotted, showing resistance against time, as mentioned previously.
4. The oil should be filtered to standard test value of not less than 22 kV, or a new supply of oil of high dielectric strength should be used.

The above procedures also may be used with askarel-filled transformers, but with the following precautions. Oil should not be used as a substitute for any askarel-insulating fluid. Where dipping and baking, or re-insulating is necessary, the manufacturer should be consulted regarding proper materials and procedure. The askarel should be reconditioned, making standard IEEE tests until breakdown values reach not less than 25 kV, or replaced with new askarel.

Cables and Wiring

- All open wiring, including nonmetallic, sheathed cable, can be retained generally after thoroughly drying both cable and junction boxes and remaking connections.
- Armored cable usually will have to be replaced, as will lead cable if the ends have been under water. Salt water is particularly damaging.

- Rubber-covered cable in rigid conduit or in electrical metallic tubing may sometimes be reused, but it must be pulled out of the conduit or tubing in order to clean the conduit or tubing. Care must be exercised in this operation, as the cable insulation may be easily damaged. The conduit or tubing must be thoroughly cleaned of all silt and moisture prior to being used again.
- Potheads and all insulators should be cleaned and carefully inspected for cracks or other damage.