Instructions for Handling Inerteen® Insulating Fluid P.D.S. 54201 CM and Installation and Maintenance of Inerteen Transformers



Westinghouse Electric Corporation

POWER TRANSFORMER DIVISION, SHARON, PENNSYLVANIA • MUNCIE, INDIANA
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Part I — Inerteen® Insulating Fluid

See American National Standards Institute Guidelines C107.1-1974 for complete information on handling and disposal of Askarels. Copies are available from: ANSI, 1430 Broadway, New York, N.Y. 10018

CHARACTERISTICS

Inerteen is a highly pure, synthetic non-inflammable and non-explosive insulating and cooling liquid. Chemically stable and nearly water white in color, Inerteen is not affected by reaction with other materials regularly used in the manufacture of Inerteen apparatus. It is non-oxidizing and non-corrosive at temperature considerably above those normally obtained in Inerteen apparatus. Inerteen will not sludge under any operating condition. Water is the main enemy of Inerteen and keeping it dry will insure long service life.

The dielectric strength of Inerteen will compare favorably with that of insulating oil when tested under the same conditions. Quality samples of Inerteen tested under laboratory conditions may show a dielectric strength in excess of 40KV. Care must be exercised in handling and testing Inerteen. Inerteen must be kept in clean, sealed containers to prevent loss by evaporation or contamination by moisture or dirt.

Inerteen exerts a strong solvent action on most varnishes, gums, and paints. Such materials are not used in the construction of Inerteen apparatus. No materials should be used in Inerteen apparatus except those approved by the Westinghouse Electric Corporation.

Inerteen has an irritating effect upon the skin. If it is necessary to handle it, see the precautions under "Handling". It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is impossible to separate mineral oil and Inerteen.

SPECIFIC CHARACTERISTICS OF INERTEEN

As outlined in "Method of Testing Askarels A.S.T.M. D901," the specific characteristics of Inerteen are:

1. Burn point: None
2. Chemical stability: No generation of free chlorides under normal operating conditions.
3. Color: (Maximum) 100 A.P.H.
4. Condition: Clear
5. Dielectric constant:
   At 1000 hertz 77°F (25°C), 5.7 to 5.9
   At 1000 hertz 212°F (100°C), 4.8 to 5.0
6. Dielectric strength: (Minimum) 77°F (25°C)
   At point of shipment, 35KV
   At point of receipt, 30KV
7. Electrical Resistivity: (Minimum)
   500 x 10^6 ohms/cm^3 (212°F (100°C) at 500 volts DC)
8. Power factor:
   At 60 hertz, 77°F (25°C) 2%
   At 60 hertz, 212°F (100°C) 25%
9. Fixed chlorine content: (Minimum) 42 percent
10. Free chlorides: Less than 0.10 ppm
11. Neutralization number: Less than 0.014 mg of KOH/gram
12. Pour Point: (Maximum) plus 7°F (minus 14°C)
13. Refractive index:
    At 77°F (25°C), 1.624 to 1.626
14. Specific gravity:
    At 60°F/60°F (15.5°C/15.5°C), 1.381 to 1.392
15. Density: 11.5 pounds per gallon
16. Viscosity:
    At 100°F (37.8°C), 82-92 seconds
17. Moisture: (Maximum) 35 ppm

ENVIRONMENTAL CONSIDERATIONS

Inerteen is a synthetic insulating fluid made by the chlorination of a relatively common chemical, biphenyl. The chlorination is necessary to impart nonflammable properties to the Inerteen. The resulting polychlorinated biphenyls (PCB's) are relatively insoluble in water but soluble in fat,

SAMPLING AND INSPECTION

Sampling. Each container of Inerteen must be sampled and tested prior to being added to a transformer and then should be added only if the dielectric strength is 30KV or above.

It is desirable that periodic inspection of Inerteen apparatus be made and that samples of Inerteen be taken from each compartment and tested. Initially a sample should be taken after about 3 months of operation and then, where operating conditions permit, at intervals of 6 months to 1 year. Accurate records should be maintained and if dielectric strength drops below 22KV it should be reconditioned.

If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service" below.

Westinghouse Inerteen Testing Service. Many users of Inerteen do not have the necessary facilities for testing. In order that these users may be able to make the periodic tests recommended, Westinghouse Electric Corporation has established an Inerteen testing service to provide careful tests by experienced engineer, and provide a prompt report on the test results.

Two special 16 oz. sample bottles per mailing container Westinghouse S#24B1743602, as well as necessary packing and printed matter, may be obtained by contacting the nearest Westinghouse Office. (The bottle and the container will not be returned to the customer.)

After drawing the sample of Inerteen, the customer should seal the bottle and mail it to the Westinghouse Electric Corporation, Materials Engineering Laboratory, Sharon, Pa. 16146. To simplify these details, an instruction and order sheet and a printed return label have been included in the carton container. The instructions cover the taking of the sample and its proper preparation for mailing. The order sheet must be sent to the nearest Westinghouse office.

In addition to dielectric tests, Westinghouse is also prepared to make a physical and chemical examination if so requested. (The customer should plainly indicate the type of service desired.)

The physical and chemical examination consists of an examination of the Inerteen by a competent chemist. Recommendations will be made as to the suitability of the Inerteen for continued use, whether it would be desirable and economical to clean it, and in a general way, the preferred method of cleaning. In submitting samples for this service, the history of the Inerteen represented should be given as completely as possible. (For details refer to the nearest Westinghouse Office).

SAMPLING INERTEEN

The dielectric strength of Inerteen is affected by the most minute traces of certain impurities, particularly water. It is important that the greatest care be taken in obtaining the samples and in handling them to avoid contamination. There have been low dielectric test results reported from the field which, upon investigation, have been found to be largely a matter of poor sampling. All sampling and testing equipment used for handling Inerteen and servicing Inerteen should be used for no other purpose. Care must be used in taking samples of Inerteen and sealing them prior to testing. It is desirable that samples of Inerteen be removed from any container on clear days only, and when the temperature of the Inerteen is at least as high as the temperature of the surrounding air.

Use only tin containers with screwed metal caps or glass bottles with Inerteen resistant lids to hold Inerteen samples. If it becomes necessary to use other than factory sampling containers, they should be rinsed with clean naptha, washed with detergent and water, and rinsed thoroughly in hot water, and then dried at approximately 110°C for four hours with neck down in circulating air oven. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place. An aluminum foil liner should be put in the b

cup. (A suitable test cup is shown in Fig. 1, and portable testing outfits in Fig. 2.)

a. Procedure

The spacing of electrodes shall be checked with a standard round gauge having a diameter of 0.100 in., and the electrodes then locked in position.

The electrodes and the test cup shall be wiped clean with dry, calendered tissue paper or with a clean, dry chamois skin and thoroughly rinsed with Inerteen-free, dry benzine until they are entirely free from fibers.

The test cup shall be filled with dry benzine, and voltage applied with uniform increase at the rate of approximately 3000 volts (rms) per second until breakdown occurs. If the dielectric strength is not less than 25KV, the cup shall be considered in suitable condition for testing the Inerteen. If a lower test value is obtained the cup shall be cleaned with benzine and the test repeated.

The temperature of the test cup and of the Inerteen when tested shall be the same as that of the room, which should be between 68°F and 86°F. (20°C and 30°C) Testing at lower temperatures is likely to give variable results which may be misleading.

The sample in the container shall be agitated with a swirling motion (to avoid introducing air) so as to mix the Inerteen thoroughly before filling the test cup. This is even more important with used Inerteen than with new Inerteen as the impurities may be precipitated and the test may be misleading.

The cup shall be filled with Inerteen to a height of no less than 0.79 in. (20 mm) above the top of the electrodes.

The Inerteen shall be gently agitated by rocking the cup and allowing it to stand in the cup for three minutes before the first and one minute before each succeeding puncture. This will allow air bubbles to escape.

Voltages shall be applied and increased uniformly at a rate of approximately 3000 volts (rms) per second until breakdown occurs as indicated by a continuous discharge across

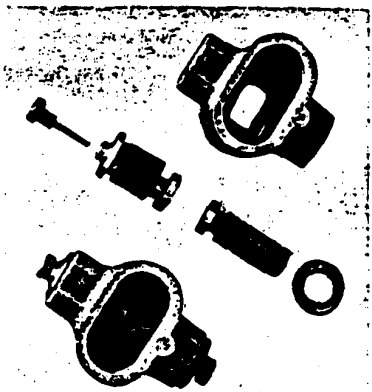


Fig. 1. Fluid Test Cup for Dielectric Test

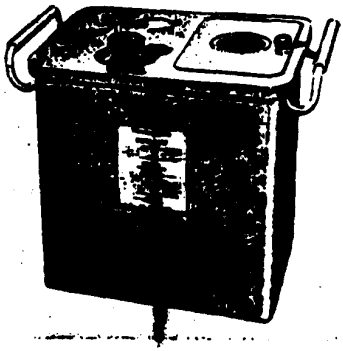


Fig. 2. Portable Oil Testing Set, 1/2 KVA, 35,000 Volts

should be taken to see that these materials are thoroughly dry prior to use. Any equipment used for conditioning Inerteen should first be thoroughly cleaned with benzine or naphtha to remove all traces of material foreign to Inerteen. If at all possible, separate equipment should be used for filtering Inerteen only.

Hydrogen chloride, caused by arcing, may be eliminated by vigorously bubbling dry nitrogen through Inerteen. This should be done as quickly as possible following the failure to prevent the attack of HCl on the cellulose insulation. The nitrogen should be passed in through the drain valve at the bottom and allowed to escape through a vent at the top. The nitrogen should be discharged through a pressure regulator attached to a stand pipe above the level of the Inerteen in the transformer to prevent the Inerteen from flowing into the regulator. The nitrogen should be bubbled through the Inerteen at a rate of one to three cubic feet per minute for a period of 4 to 6 hours. This may require two to eight cylinders (220 cu. ft. each) depending on the size of the apparatus.

DISPOSAL

Inerteen Liquid. Collect all scrap Inerteen liquid in a suitable metal container which can be satisfactorily sealed. Once the Inerteen is collected it may be returned in sealed drums or tank cars to Monsanto or other certified disposal companies as listed below. Ship prepaid to:

Monsanto Company W. G. Krummrich Plant Sauget, Illinois Attention: Supervisor Dept., 246	Rustan Engineering Company Disposal Division Sheffield, Illinois
Chem-Trol Pollution Service, Inc. 4818 Lake Avenue Blasdell, New York 14219	Rollins-Purle, Inc. Box 2349 Wilmington, Delaware 19899

A charge will be made for all returned Inerteen.

Solvent-Rinses Contaminated with Inerteen. Solvent rinses or other liquids contaminated with Inerteen should also be collected in sealed drums or tank cars and sent either to Monsanto or other certified disposal company.

Solids Contaminated with Inerteen. All solids materials contaminated with Inerteen must be stored in impervious containers until disposal. This includes all glass, metals, papers, insulation, clay rags, filter cartridges, etc.

These materials may be incinerated if suitable arrangements can be made for it to be done at a temperature sufficient to breakdown the Inerteen. Or they may be purged by cleaning with a proper fluid and the resultant fluid then may be incinerated using an approved procedure and temperature.

The following disposition is recommended for various materials.

Material	Disposition
Absorbing clay, filter paper, cartridges sawdust and rags	Incinerate
Coils	Solvent clean or incinerate
Cores	Solvent clean
Tanks & Frames	Solvent clean
Copper or Aluminum	Solvent clean
Insulation	Incinerate

Incineration. Incineration, whether of liquids or contaminated solid materials, must be done at a temperature of at least 2250°C and the stack must be equipped with a suitable scrubber to remove HCl.

Cleaning Contaminated Drums. The cleaning of drums which have contained used Inerteen requires great care in order to insure a thoroughly clean drum.

It is preferable to return such drums to the supplier where adequate cleaning facilities are available, rather than to attempt to clean them.

If it is necessary to clean such drums, the following procedure is recommended:

Rinse the drum thoroughly with gasoline or petroleum distillate, using about one gallon each time, until the solvent shows no discoloration after using. Allow it to drain, then pump out the last traces of solvent with a vacuum pump, using a brass pipe flattened at

condition when shipped; but it is desirable to inspect each transformer thoroughly before placing it in service.

When a transformer is shipped complete and filled with Inerteen, this inspection should include a check of the Inerteen level, the tightening or adjustment of any parts that may have become loose or out of place, and determining the extent to which moisture may have entered the transformer. The latter can best be determined from the dielectric strength of the Inerteen. Inerteen used for filling transformers should have a dielectric strength of 30KV or higher. When it tests less than this the Inerteen should be filtered. If the dielectric strength is very low or if there is any other evidence of moisture, it is necessary to dry the transformer.

Inerteen transformers should be dried by the short circuit method with the transformer immersed in the Inerteen and with the tank sealed tightly. During the drying out operation, the Inerteen should be circulated through a filter press or preferably through an Inerteen conditioner. A filter press will remove dirt and most of the moisture, but the conditioner will remove these and other contaminating materials as well.

The desired load current should be obtained by short circuiting one winding and impressing the proper impedance voltage on the other winding. The full load impedance may usually be found on the instruction plate for the transformers; if the impedance of the transformer is not known, it should be requested from the Westinghouse Electric Corporation, Sharon, Pennsylvania, by identifying the transformer with its serial number.

If the transformer is at or lower than room temperature at the start of the drying process, circulation of 125 to 150% of full load current will hasten the heating, and a higher top Inerteen temperature can be obtained more quickly by blanketing the coolers when tubular coolers are used or by shutting off the radiator valves when radiators are used. The cover should be lagged to prevent condensation.

The loading should be carefully watched and when the top Inerteen reaches a temperature of 60°C, the load should be reduced to obtain an approximately constant top Inerteen temperature based on the following table:

Short Circuit Amperes in Percent of Load	Maximum Temperature of the Top Inerteen
50%	85°C
75%	80°C
85%	75°C

While the windings of the transformer heat up, do not permit the temperature of the top Inerteen to exceed the value specified for a given percentage of load. This precaution is necessary because the windings will heat up more quickly and operate at a higher temperature than the Inerteen. If the windings are allowed to reach too high a temperature, the insulation will be damaged. The drying of a transformer should be continued until the dielectric strength of samples of Inerteen taken from the transformer test at 30KV or higher.

The cover should be kept tightly sealed during the temperature run, and until the transformer has cooled down to room temperature to prevent condensation. This also prevents the release of hot Inerteen vapors which are quite objectionable, particularly if the ventilation is poor.

CAUTION: It is not safe to attempt the drying out of transformers unless constant attention is given to the job.

ACCESSORIES AND FITTINGS

Bushings, fittings, and accessories when boxed and shipped separately should be mounted as shown on the outline drawing. Proper installation

directly to the transformer or the complete transformer is placed in an auxiliary vacuum tank.

1. Apply and maintain continuously a vacuum of at least 28 inches of mercury for at least one-half hour to units rated 25KV and below, or for four hours to units above 25KV.

2. While retaining the vacuum, slowly fill with Inerteen to the normal 25°C level or with approximately 90% of the required amount where it is impossible to gauge properly.

3. Maintain the specified vacuum for at least one-half hour after filling.

4. Adjust Inerteen to normal level and seal the transformer tank. Do not reopen until the temperature at the top of the fluid is equal to or higher than the ambient temperature in order to avoid condensation on the surface of the Inerteen.

In those cases where the transformers are not filled under vacuum, full voltage should not be applied to the windings for at least 24 hours after the Inerteen has been put into the case. This time is necessary to allow the air bubbles to escape.

PLACING IN SERVICE

Pressure Testing. All Inerteen transformers are pressure-tested at the factory and shipped free of leaks. After installations and before voltage is applied, it is desirable to pressure-test each transformer, especially if any fittings or covers have been removed and replaced during installation. Compressed dry nitrogen or dry air may be used for the purpose. It is recommended that the space above the Inerteen be blown out with dry nitrogen, then close all vents and apply a pressure-test of five pounds per square inch for a period of six to eight hours. The test pressure can best be limited by the use of a pressure regulator attached to the nitrogen cylinder. A check for leaks of joints above the Inerteen level may be made by painting them with a solution of soap and glycerin and watching for gas bubbles. At the conclusion of the test the internal pressure should be returned to normal by momentarily venting the gas space.

High Altitude. Where transformers are to be used at a high altitude (more than 3000 feet above sea level) a fitting above the liquid level should be opened to equalize the internal and external pressures at a temperature of approximately 25°C before placing the transformer in service.

Grounding Transformer Tank. Regardless of the type of foundation or floor on which a transformer is to rest, the tank should be definitely and permanently grounded to eliminate the possibility of obtaining static shocks or being injured by accidental grounding of a windings to the case. A ground pad or lug is always provided near the bottom of the tank for the purpose of connecting the grounded lead.

> **CAUTION:** A good low-resistance ground is necessary for adequate protection — a poor ground may be worse than none at all.

Grounding Low Voltage Winding. Every effort is made in insulating transformers to guard against any chance of breakdown between high voltage and low voltage windings; however, in order to be absolutely safe, it is advisable that low voltage circuits with which persons may come in contact be grounded. The maximum voltage that can be obtained to ground is then limited to the normal voltage that exists between the grounded point and the line; this is true even though the high voltage and low voltage windings become connected electrically.

In grounding the winding, the neutral point should be used if it is available. When transformers operate on single phase circuits with the middle point of the low voltage, the maximum voltage that can exist between any part of the low voltage circuit and ground is one-half of the low voltage.

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MAKING CONNECTIONS

A diagram, usually on the metal instruction plate attached to the side of the case, shows the proper