

ATTACHMENT 2

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



Westinghouse Electric Corporation

**SMALL POWER TRANSFORMER DIVISION, SOUTH BOSTON, VIRGINIA
SHARON TRANSFORMER DIVISION, SHARON, PENNSYLVANIA**

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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)
 500×10^9 ohms/cm² (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,

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and extremely persistent in the environment. It has been shown by several laboratories that measurable amounts of the PCB's, particularly those with more than 50% chlorination, are present in our general environment and are a threat to certain species of wildlife. While Inerteen is generally regarded as being non-toxic to humans, very high standards of control in the overall program against pollution must be exercised.

Electrical apparatus (such as transformers and capacitors) using Inerteen are normally sealed to prevent escape of Inerteen into the environment. However, a carefully planned program of waste disposal must be followed at every step of the equipment life. This includes manufacture, repair and final disposition of the fluid and the Inerteen contaminated parts. To date the only acceptable destruction of the PCB's is by incineration at 2250°C or higher under carefully controlled conditions. At this temperature Inerteen will breakdown into HCl, CO₂ and water vapor. An alkaline scrubber is necessary to neutralize the HCl and the final products released to the atmosphere are CO₂ and steam. To be sure that the Inerteen and Inerteen contaminated materials do not contaminate the environment they must be incinerated in approved equipment.

HANDLING

1. Safety Precautions

Breathing. The odor of Inerteen is noticeable at concentrations below the Maximum Acceptable Concentration. Concentrations which exceed this may cause irritation of the eyes, nose, throat and upper respiratory tract. Much higher concentrations could cause internal reactions.

Swallowing. Inerteen is highly toxic if taken internally. Swallowing of an ounce or two could cause severe irritation of the digestive tract and serious internal reactions.

Skin Irritation. Although Inerteen is only a moderate skin irritant when contact is for

short duration, it can be absorbed through the skin. Repeated contact over prolonged periods may result in severe dermatitis which may persist for many months after removal from exposure.

Protective Equipment. When necessary, under emergency conditions, to enter a space containing very high concentrations of Inerteen fumes or vapor, either an approved gas mask or self-contained breathing equipment, should be worn. For lower, but still significant concentrations, cartridge type chemical respirator should be worn. If the odor of Inerteen is noticed while wearing respiratory equipment, the wearer should go immediately into fresh air.

Neoprene coated aprons and neoprene coated gloves may be used where necessary to protect the skin. Hand cream designed to protect against oils and petroleum solvents, (such as Ply 9 Gel made by Milburn Co. of Detroit) may be of some value where the use of gloves is not practical.

When handling Inerteen, wash hands often with warm soapy water and in case of spillage onto clothing, remove the clothing as soon as possible. The clothing must then be laundered prior to use.

2. Storage

Inerteen is shipped in tank cars, drums or cans. Inerteen in drums or cans should be stored in a covered area and when stored out-of-doors the bungs should be down to prevent collection of water around the bung. A storage tank should be mounted on piers above the ground and accessible to all points for inspection for leakage. There should be a curb on the ground around the tank to contain any spillage or leakage.

It is desirable, if possible, to keep Inerteen in storage at a temperature slightly above ambient to prevent moisture condensation.

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 naphtha, 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 lid.

Provision is made on all Inerteen transformers to obtain a top sample of the Inerteen, however on a transformer that is in operation, a sample may be taken from either the top or bottom since any moisture present will be mixed in, due to circulation of Inerteen. In sampling, allow at least one quart of Inerteen to run out to flush the sampling connection before collecting the sample. This flush material must be collected in a suitable container for disposition as per the section on "Inerteen Disposal" page 6. The Inerteen should be put into the sample containers immediately and the caps screwed on tightly. The label for each container should be marked clearly with the serial number of the transformer or compartment from which the Inerteen was taken.

Before taking samples from a storage tank, the Inerteen should be allowed to settle for approximately twelve hours so that if there is any moisture present, it, having a lower specific gravity, will rise to the top where the sample is to be taken. A clean sneak-thief should be used to obtain the samples. Essentially, the same precautions to prevent moisture and dirt contamination should be used as outlined above.

It is recommended that one 16 oz. bottle of Inerteen be taken as a sample for testing. At least one sample should be taken from a tank car of Inerteen. One sample may be taken from each drum, or if desired, a composite sample may be made from Inerteen from five drums, provided all of the drums are airtight. When the bung is first loosened, a hissing sound should be heard, which indicates that the drum has been airtight. When the composite type of testing is used and a sample is found to be unsatisfactory, a sample from each of the drums represented must be tested.

When drums have been stored exposed to the weather, a sample from each drum must be tested to determine if it is suitable for use.

DISPOSITION OF SAMPLE & CONTAINER. All samples must be collected in sealed, labelled containers for disposition as described in section on "Inerteen Disposal" page 9. All solvent rinses of test containers must be handled in a like manner.

All containers, rags, and other solid materials involved in testing must be collected for proper disposition.

TESTING METHODS

Instruction for all tests listed correspond in general to the recommendations of the American Society for Testing Materials.

1. Dielectric Strength Test

The testing transformer and the source of supply of energy shall not be less than 1/2 KVA, and the frequency shall not exceed 100 Hertz per second. Regulation shall be so controlled that the high tension testing voltage taken from the secondary of the testing transformer can be raised gradually without opening either primary or secondary circuit. The rate of rise shall approximate 3000 volts per second. The voltage may be measured by an approved method which gives root-mean-square values.

Some protection is desirable to prevent excessive flow of current when breakdown of the Inerteen takes place. This protection preferably should be in the primary or low voltage side of the testing transformer. It is not especially important for transformers of 5 KVA or less, as the current is limited by the impedance of the transformer.

The standard test cup for holding the sample of Inerteen shall be made of a material having a suitable dielectric strength. It must be insoluble in and unattacked by Inerteen or benzene and non-absorbent as far as moisture, Inerteen, or gasoline are concerned.

The electrodes in the test cup between which the sample is tested shall be circular discs of polished brass or copper, 1 in. in diameter, with square (90°) edges. The electrodes shall be mounted in the test cup with their axes horizontal and coincident, with a gap of 0.100 in. between their adjacent faces, and with tops of electrodes about 1-1/4 in. below the top of the

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 65°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

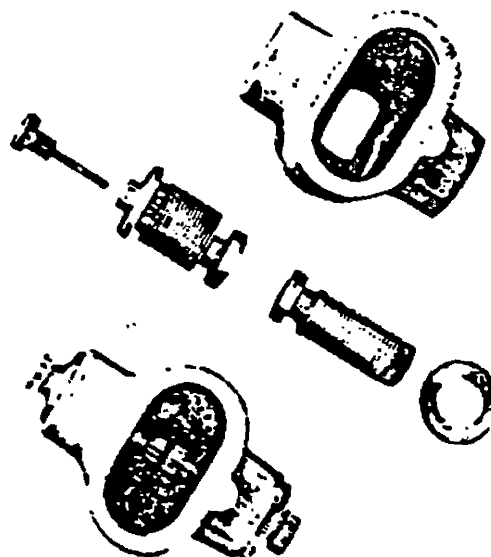


Fig. 1. Fluid Test Cup for Dielectric Test

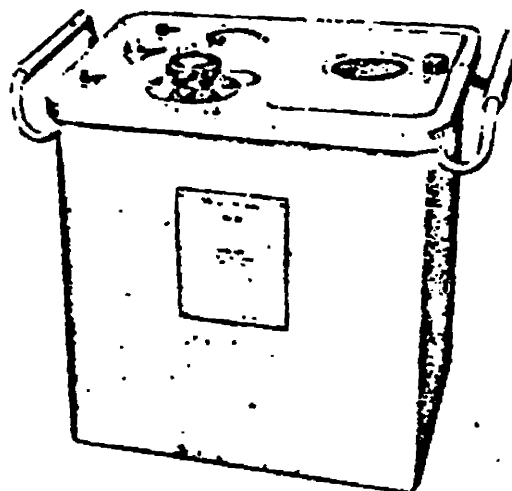


Fig. 2. Portable Testing Set. 1-2 KVA, 35,000 Volts

the gap. (Occasional momentary discharges which do not result in a permanent arc may occur; these should be disregarded).

b. Number of Tests

I. Except as specified in (II) one breakdown test shall be made on each of five fillings of the test cup. If the average deviation from the mean exceeds 10 percent or if any individual test deviates more than 25 percent from the average, additional tests shall be made. The dielectric strength shall be determined by averaging the first five tests that conform to the allowable variations.

II. When Inerteen is tested in considerable quantity, so that the time required for testing is excessive and when it is merely desired to determine whether the breakdown safely exceeds the limit specified, or in those cases where the amount of Inerteen available for test may be very limited, one breakdown test shall be made on each of two fillings of the test cup. If neither breakdown is below this value, the Inerteen may be considered satisfactory and no further tests shall be required. If either of the breakdowns is less than the specified value a breakdown shall be made on each of three additional fillings and test results analyzed in accordance with (I).

c. Report

The report shall include the volts (rms value) at each breakdown and the average of the two or five breakdowns and the temperature of the Inerteen at the time of the test.

2. Neutralization Test

The Neutralization number is the number of milligrams of potassium hydroxide required to neutralize the acid in one gram of Inerteen.

Solutions Required

a. Standard Potassium Hydroxide Solution (alcoholic, 0.1N) - add 6 g. of c.p. solid KOH

to 1 liter of c.p. anhydrous isopropyl alcohol. Boil, add 2 g. of c.p. Ba (OH)₂ and boil again. Cool, filter and store in a chemically resistant bottle protected by a guard tube containing soda lime and soda asbestos (Ascarite). Standardize against pure potassium acid phthalate using phenolphthalein as an indicator.

b. Titration Solvent - Add 500 ml. of c.p. benzene and 5 ml. of water to 495 ml. of c.p. anhydrous isopropyl alcohol.

Procedure. Into a 250 ml. Erlenmeyer flask introduce 40 g. of Inerteen weighed accurately. Add 100 ml. of the titration solvent and 3 ml. of the indicator solution. Titrate immediately at a temperature below 30°C. Consider the end point definite if the color change to green persists for 15 seconds. A blank shall be determined on the solvent.

Calculations. The neutralization number or mg.

$$\text{KOH per g. of Inerteen} = \frac{(A-B)(N) \times 56.1}{W}$$

A = ml. KOH solution required for sample.

B = ml. KOH solution required for blank.

N = normality of KOH solution.

W = grams of sample used.

RECONDITIONING

Reconditioning will be necessary to remove water, foreign material and hydrogen chloride which may be present and contaminating Inerteen. The blotter filter press, cartridge filter and the Inerteen conditioner will remove water and dirt which may be present. Various models of each of these types of apparatus are available. The Inerteen conditioner is the most effective for removing moisture, dirt, and other contaminating materials. It basically consists of a clay container, a clay filter, pump, attendant valves, gauges and fittings.

Water cannot be effectively removed from either clay or filter material once they have become saturated with Inerteen therefore care

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 benzene 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 Industrial Chemicals Company 800 North Lindbergh Boulevard St. Louis, Missouri 63166		Nuclear Engineering Company Disposal Division Shelfield, Illinois 61361
Chem-Tek Pollution Services, Inc. 1550 Balmain Road Model City, New York 14107		Wes Con. Inc. 409 Shoshone Street, South P. O. Box 564 Twin Falls, Idaho 83301
Rollins Environmental Services, Inc. P.O. Box 221 Bridgeport, N.J. 08016	P.O. Box 609 Deer Park, Texas 77536	11351 Scenic Highway Baton Rouge, La. 70807

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

the lower end to explore the corners of the drum. Collect all solvent rinse material for disposition as described above.

CAUTION: Do not use a steel pipe because of the danger of a spark igniting the gasoline or petroleum distillate vapor.

dry air to remove any lingering explosive vapors. Screw the bung on tightly before removing the drum from the oven. Use a new washer with the bung to insure a tight seal.

CAUTION: Open flames must always be kept away from the oven to prevent igniting inflammable gases which might be remaining in drum when placed in the oven.

Next, heat the drum with bunghole down in a ventilated oven at a temperature of at least 88°C. (190°F) for sixteen hours. (A simple oven for this purpose may be made from sheet metal and heated with steam or an electric heater.) Blow out the drum with dry nitrogen or

The practice of refilling drums with Inerteen is undesirable and should be avoided whenever possible, for unless the utmost precautions are taken, the Inerteen is likely to become contaminated.

Part II — Installation and Maintenance of Inerteen Transformers

INSTALLATION

For convenience in handling, all transformers are equipped with lugs or eyes for lifting and moving the complete assembly filled with Inerteen by use of a crane. Additional means are provided for the heavier parts such as covers, core and coils, radiators and terminal chambers. Jacking lugs are also supplied on either the base or corners of the tank. A transformer should only be lifted or moved by jacks placed against these lugs and not against the cooling tubes, radiator valves, or other fittings.

An indoor installation requires that the room in which the transformers are placed must be well ventilated so that the heated air can readily escape and be replaced by cooler air from the outside. If the room is poorly ventilated, this exchange of air takes place too slowly and the temperature of the air in the room may become excessively high. At any given load the temperature rise of a self-cooled transformer will be a fixed number of degrees above the temperature of

the surrounding air. The temperature of the transformer is the sum of this rise and the air temperature; therefore, care must be taken to provide a room sufficiently ventilated to permit operation of transformers at a reasonable temperature. Area of the air inlets should be such that the ambient temperature never exceeds 40°C (104°F) with an average over twenty-four hours not exceeding 30°C (86°F); 50 to 60 square feet per 1000 kva of transformer capacity has been satisfactory. Outlet openings with the same total area should be provided.

Self-cooled transformers should always be well separated from one another and from adjacent walls, partitions, etc., in order to permit free air circulation about the cases. This separation should not be less than 24 to 36 inches depending on the size of the units.

INSPECTION

All Inerteen transformers are carefully inspected and tested at the factory and they are in good

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

instructions when necessary are included in the instruction leaflets for component parts. Care must be exercised when these components are fitted to eliminate the accidental introduction of moisture in any form inside the transformer. Where blind flanges are removed before fittings are mounted, the level of the Inerteen must be lowered below the openings that will be made.

FINISH

Any portion of the paint film damaged during shipment or installation must be repaired as quickly as possible.

To do this, clean the damaged portion by means of a scraper or sandpaper, wipe thoroughly with a solvent dampened cloth, apply Westinghouse primer paint and allow it to dry for at least 24 hours, then apply a coat of Westinghouse finish paint.

FILLING

When putting new apparatus into service, see that the apparatus tank is free from moisture and foreign material.

IMPORTANT: Extreme precautions must be taken to insure the absolute dryness and cleanliness of the apparatus before filling it with Inerteen, and to prevent the entrance of water and dirt during the transfer of the Inerteen to the apparatus.

The preparation and filling of outdoor apparatus should preferably be done on a clear, dry day; if this is not possible, protection against moisture must be provided.

All vessels used for transferring the Inerteen should be carefully inspected to see that they are absolutely dry and free from contamination. Use only all-metal hose or pipe when filling, since the lining of most other types of hose may be soluble

in Inerteen and will contaminate it in a short time. All joints should be tight; where practical, fill through the drain valve to keep aeration to a minimum and vent the top of the tank to allow the air to escape. Be sure that valves and pipe connections between the main tank and any Inerteen filled compartments are open for free circulation of gas and liquid. Otherwise, trapped air or gas may cause the Inerteen level in some parts of the transformer to be below the safe operating level.

If it is necessary to fill a transformer out-of-doors, particularly on a damp day, care should be taken to prevent the entrance of moisture. In order to avoid condensation the temperature inside the unit should be kept several degrees above the outside air temperature.

The tank and compartments, if any, should be filled at ambient temperature to the point on the gauges marked "25° - Liquid Level." If the ambient varies greatly from 25°C (77°F) when filled, the Inerteen level should be checked when the average fluid temperature is 25°C; sufficient Inerteen should be added to or drained from the tank to bring the level to the proper height. The transformer should never be operated or left standing, even out of service without the Inerteen level being indicated on the gauge.

Filling Under Vacuum. Entrapped air is a potential source of trouble in all liquid filled transformers. Therefore, it is desirable to fill all Inerteen transformers under a full vacuum. This is done for the transformers shipped from the factory and should be done where practicable when transformers are filled in the field, providing the transformer cases have been so designed. If the cases have not been designed for full vacuum and it is imperative to get the maximum winding impulse strength immediately, the transformers should be filled with Inerteen under full vacuum by placing them in an auxiliary vacuum tank.

Where purchaser does not have an established technique for vacuum filling, the following procedures may be used whether vacuum is applied

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 winding 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 voltages.

MAKING CONNECTIONS

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

power terminal connections to be made for various voltages. Care should be taken to see that all connections and only those shown are properly made, for a wrong connection may cause severe damage.

Some installations require an auxiliary source of power or control leads to be wired to terminals at the transformer; a wiring diagram, either a separate drawing or included as part of the outline drawing, shows the connections to be made.

Voltage Application. When voltage is first applied to the transformer, it should, if possible, be brought up slowly to its full value so that any wrong connection or other trouble may be disclosed before damage can result. After full voltage has been applied successfully, the transformer should be operated without load for a few hours. It should be kept under close observation during this time and also during the first few hours while loaded.

INSPECTION

It is desirable that periodic inspections of Inerteen apparatus be made and that samples of Inerteen be taken from each and from all compartments of any apparatus and tested after a short period of service. See section on Sampling and Inspection.

Any increase in operating temperature at normal load should be investigated and if the cause cannot be determined, the transformer

should be taken out of service and given a thorough inspection.

Any symptoms, such as unusual noises, high or low Inerteen levels, operation of relief device, etc., should be investigated at once.

Transformers which have been subjected to unusually severe operating conditions, such as overloads, frequent short circuits, or special units should be inspected at least once a year. This can usually be done adequately by lowering the Inerteen level and inspecting with a light through the manhole. Before this inspection is made, the Inerteen should be allowed to cool to reduce the amount of Inerteen fumes given off which are quite objectionable and should not be inhaled.

During periodic inspection, all accessories should be inspected to see if they are operating properly.

CAUTION: Never enter a vault or any other confined area in which a transformer relief device has been known to operate or in which a transformer has failed, until the area has been thoroughly ventilated. Then enter cautiously, with another person in attendance. The pungent, somewhat irritating fumes of hydrogen chloride are easily detected and can serve as a guide in entering the enclosure.

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