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

Westinghouse Electric Corporation

Power Transformer Division, Sharon, Pa.

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Part I — Inerteen® Insulating Fluid

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 temperatures 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 40 kv. 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 caution note on the title page. 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 cycles 77°F (25°C), 5.7 to 5.9
At 1000 cycles 212°F (100°C), 4.8 to 5.0

6. Dielectric strength: (Minimum) 77°F (25°C)

At point of shipment, 35 kv
At point of receipt, 30 kv

7. Electrical Resistivity: (Minimum)

500×10^9 ohms/cm^3 (212°F (100°C) at 500 volts d-c)

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 NaOH/gram

12. Pour Point: (Maximum) plus 2°F (minus 19°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

HANDLING

CAUTION

Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly

when hot, should be avoided. The eyes, nose, and lips are effected when Inerteen comes in contact with them. All safety precautions must be observed when handling Inerteen.

If accidently spilled on the hands, no skin irritation will occur if the parts are thoroughly washed with soap and water. Continued exposure may cause eruptions on some individuals due to the absorption of Inerteen through the pores of the skin. Hot apparatus should not be opened except in a well-ventilated area. Large quantities of Inerteen should be handled in a closed system. In case Inerteen is spilled on one's clothing, the clothing should be changed at once and laundered before being worn again. Inerteen resistant gloves should be worn when it is necessary to work in Inerteen. If Inerteen gets into the eyes, flush with water and get eye first aid from a physician. Castor oil is recommended for the eyes, castor oil or skin cream for the nose and lips. CLEANLINESS AMONG WORKMEN HANDLING INERTEEN IS A VERY GOOD SAFEGUARD AGAINST SKIN IRRITATION.

NOTE

Always use all-metal hose or pipe when handling the Inerteen. Rubber hoses should not be used. Inerteen can easily become contaminated from the rubber, and should not be allowed to come in contact with it.

When it is necessary to transfer Inerteen to apparatus the apparatus must be at least as warm as the Inerteen. All Inerteen should be circulated through an Inerteen conditioner or filter press to remove scale or rust.

A drum of cold Inerteen when taken into a warm room will "sweat", and the resulting moisture on the surface may mix with the Inerteen as it flows from the drum. Before breaking the seal, the drum should therefore be allowed to stand long enough to reach room temperature, which may require eight hours, or even longer under extreme temperature conditions.

STORING

Drums

As soon as a drum of Inerteen has been unloaded, the bung should be examined and tightened if it is loose. It is possible for bungs to become loosened by change in temperature or rough handling in transit. Be sure all Inerteen is tested before using.

It is desirable that Inerteen in drums be stored indoors. Outdoor storage of Inerteen is always hazardous to the Inerteen and should be avoided if at all possible. If it is necessary to store Inerteen outside, the drums should be placed so that the bungs are down so they are protected from moisture. It is desirable to cover the drums with a tarpaulin.

TESTING SERVICE

Many users of Inerteen do not have the necessary facilities for testing it. 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 a careful test by experienced engineers, and a prompt report of test results.

Two special 16 oz. sample bottles per mailing container (W) S#1608629, 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, Plant Laboratory, Sharon, Penna. 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.*

When samples of Inerteen are received for testing, they are sent to the Plant Laboratory and tested in accordance with standard A.S.T.M. methods.

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.

Power factor test of Inerteen at 60 cycles can be made.

(For details refer to the nearest Westinghouse Office.)

RECONDITIONING

Causes of Deterioration

The principle causes of deterioration of Inerteen are:

1. Presence of water.
2. Arcing.

Arcing or burning in Inerteen produces finely divided carbon and gases which are mostly hydrogen chloride. Hydrogen chloride in the presence of moisture forms hydrochloric acid which may soon damage the insulation in the apparatus and cause rusting of ferrous materials.

Since hydrogen chloride is formed quickly after the arcing occurs, neither the Inerteen nor the apparatus should be exposed to the atmosphere (which always contains more or less moisture) until an attempt has been made to remove the hydrogen chloride.

Reconditioning

Reconditioning will be necessary to remove water, dirt and hydrogen chloride which may be present and contaminating the Inerteen.

The blotter filter press and the Inerteen conditioner will remove water and dirt deposits which may be present. Of the two methods, the Inerteen conditioner is the most effective in removing these two contaminating agents. Any equipment used for filtering Inerteen should first be thoroughly cleaned with benzine or naphtha. Every trace of any material foreign to Inerteen must be removed. 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. The nitrogen should be passed through the drain valve at the bottom of the apparatus 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 apparatus 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 four to six hours. This will require from two to eight cylinders (220 cu. ft. each) of dry nitrogen, based on apparatus containing 150 to 2000 gallons of Inerteen.

Immediate application of the bubbling process will reduce the destructive action of the hydrochloric acid on the working parts and insulation, thereby making it likely that the materials not damaged by arcing may be used in repairing the apparatus. Also, use of the process will in most cases make it possible to satisfactorily reclaim the arced Inerteen.

After the hydrogen chloride has been removed by the bubbling process, the Inerteen should be reclaimed by use of an Inerteen conditioner.

There is no commercially suitable method for separating transformer oil from Inerteen.

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 30 kv 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 30 kv 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

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 25 kv and below, or for four hours to units above 25 kv.

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 several 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 (approximately three months for transformers). Following this, when operating conditions permit, routine sampling and testing of the Inerteen at intervals of six months to one year are suggested. Accurate records should be kept of such inspections and tests and if the Inerteen shows a dielectric strength of less than 28 kv, it should be conditioned. If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service," P.L. 45-825. When an appreciable amount of Inerteen is removed from any apparatus, it should be replaced with an equal amount of new Inerteen so that the liquid level in the apparatus is maintained. The Inerteen used for replacement purposes should have a dielectric strength of not less than 30 kv.

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.

SAMPLING INERTEEN

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for handling Inerteen and servicing Inerteen 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 stoppers to hold Inerteen samples. If it becomes necessary to use other than factory sampling containers, they should be rinsed with clean naphtha, washed with strong soap suds, and rinsed thoroughly in hot water, and then dried at approximately 110°C for four hours with neck down in a circulating air oven. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

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 the Inerteen. In sampling, allow a small amount of Inerteen to run out to flush the sampling connection clean before collecting the sample. 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.

Quantity of Sample

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 the drums are airtight. When the bung is first loosened, a hissing sound should be heard, which indicates that the drum has been airtight. If the test of the composite sample is not satisfactory, a sample from each of the drums represented should 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.

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