DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health
National Cancer Institute
Bethesda, Maryland 20892

26 April 1988

Marie Ross, RN
Medical Department
General Electric Capacitor Division
Hudson Falls, NY 12839

Dear Marie:

Enclosed please find a copy of the thesis in its entirety as it has been approved by my committee at the Harvard School of Public Health.

The status of the three individual manuscripts is that the first paper on modeling has been submitted to the American Journal of Industrial Hygiene, the second paper on birth weight has been accepted with revisions at the American Journal of Epidemiology, and the third paper on cancer has yet to be submitted. I would anticipate a number of other manuscripts over the next 1 - 2 years to come from this project, though they are not specifically a part of the thesis.

I think and hope you know that this work would not have been possible without all your help over the past 10 to 12 years. It's actually somewhat hard to imagine that it's really been going on that long. In case I haven't said it often enough or recently enough, again, thank you.

I look forward to our continuing interaction and remain,

Sincerely,

Philip R. Taylor

Ref;gencorr;ross

GE Power Delivery

Capacitor & Power Protection Operation
General Electric Company
381 Upper Broadway, Fort Edward, NY 12828-1021

MARIE R. ROSS, R.N., C.O.H.N.
Supervisor, Occupational Health & Nursing
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Colby College, Maine - 1974 Certification in Hearing Conservation

Emory University, Georgia - 1979 Certificationin Pulmonary Diseases & Screening

Harvard University, Boston, MA - 1979 Industrial Hygiene

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Management, Tulane Univ., New Orleans, LA

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GE interface with NIOSH, New York State, MT. Sinai on PCB research papers

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New York State Occupational Health Nurse Assoc.
Tri-County Occupational Health Nurse Assoc.
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January 1989

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8:mfo

January 27, 1989

Mr. Thomas E. Kotoske
540 University Avenue
Third Floor
Palo Alto, California 94301

Re: David Adams, et al. v. Kentucky Power, et al.

Dear Tom:

Pursuant to the instructions of the Court and my agreement with David McCrea, I am enclosing the documents outlined in the list of exhibits for Westinghouse. In line with my conversation with David, please note that we deleted item no. 15 from the original list.

Best regards.

Yours truly,

Charles S. Cassis

Enclosures

cc: Mr. David S. McCrea

PLAINTIFF'S EXHIBIT 486

Adams, et al. v. Kentucky Power Co., et al.

C.A. No. 85-CI-1724

AMENDED
LIST OF EXHIBITS

WESTINGHOUSE ELECTRIC CORPORATION

1. Inerteen Transformers Instruction Book
Dated: Pre-1938.

2. Inerteen Transformers Instruction Book
Dated: March, 1938.

3. Inerteen Transformers Instruction Book
Dated: January, 1942.

4. Inerteen Transformers Instruction Book
Dated: November, 1946

5. Inerteen Insulating Fluid for Electrical Paratus
Dated: February, 1952.

6. Instructions for Inerteen Insulating Fluid P.D.S. 54201 KA
Dated: July, 1965.

7. Instructions for Inerteen Insulating Fluid P.D.S. 54201 CM
Dated: April, 1968.

8. Instructions for Inerteen Insulating Fluid P.D.S. 54201 CM and Installation and Maintenance of Inerteen Transformers (including Supplement)
Dated: September, 1968.

9. Instructions for Handling Inerteen Insulating Fluid P.D.S. 54201 CM and Installation and Maintenance of Inerteen Transformers
Dated: August, 1971.

10. Instructions for Handling Inerteen Insulation Fluid P.D.S. 54201 CM and Installation and Maintenance of Interteen Transformers
Dated: February, 1976.

11. Instructions for Handling Inerteen Insulating Fluid P.D.S. 54201 CM and Installation and Maintenance of Inerteen Transformers
Dated: June, 1976.

12. Westinghouse schedules of transformer serial numbers and years of manufacture.

13. Summaries of serial numbers, years, KVA work order numbers and dates of Westinghouse transformers from Kentucky Power Co. retirement work orders.

14. Summaries of serial numbers and years of manufacture of transformers from Westinghouse records corresponding to serial numbers from Kentucky Power Co.

COMMONWEALTH OF KENTUCKY
PIKE CIRCUIT COURT
DIVISION I
CIVIL ACTION NO. 85 CI-1724

DAVID ADAMS, et al. PLAINTIFFS

v. SUBMISSION OF AMENDED EXHIBIT LIST
FOR
WESTINGHOUSE ELECTRIC CORPORATION

KENTUCKY POWER CO., et al. DEFENDANTS

* * * *

Defendant, Westinghouse Electric Corporation, submits herewith its Amended Exhibit List in compliance with the Court's instructions and order of November 28, 1988.

BROWN, TODD & HEYBURN
Charles S. Cassis
Mark R. Feather

1600 Citizens Plaza
Louisville, Kentucky 40202
(502) 589-5400

ATTORNEYS FOR DEFENDANT
WESTINGHOUSE ELECTRIC CORPORATION

CERTIFICATE OF SERVICE

This is to certify that on this 27th day of January, 1989, a true copy of the foregoing pleading and the attachment was mailed to all counsel of record.

Charles S. Cassis

Adams, et al. v. Kentucky Power Co., et al.

C.A. No. 85-CI-1724

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14. Summaries of serial numbers and years of manufacture of transformers from Westinghouse records corresponding to serial numbers from Kentucky Power Co.

Westinghouse

INERTEEN TRANSFORMERS

Instruction Book

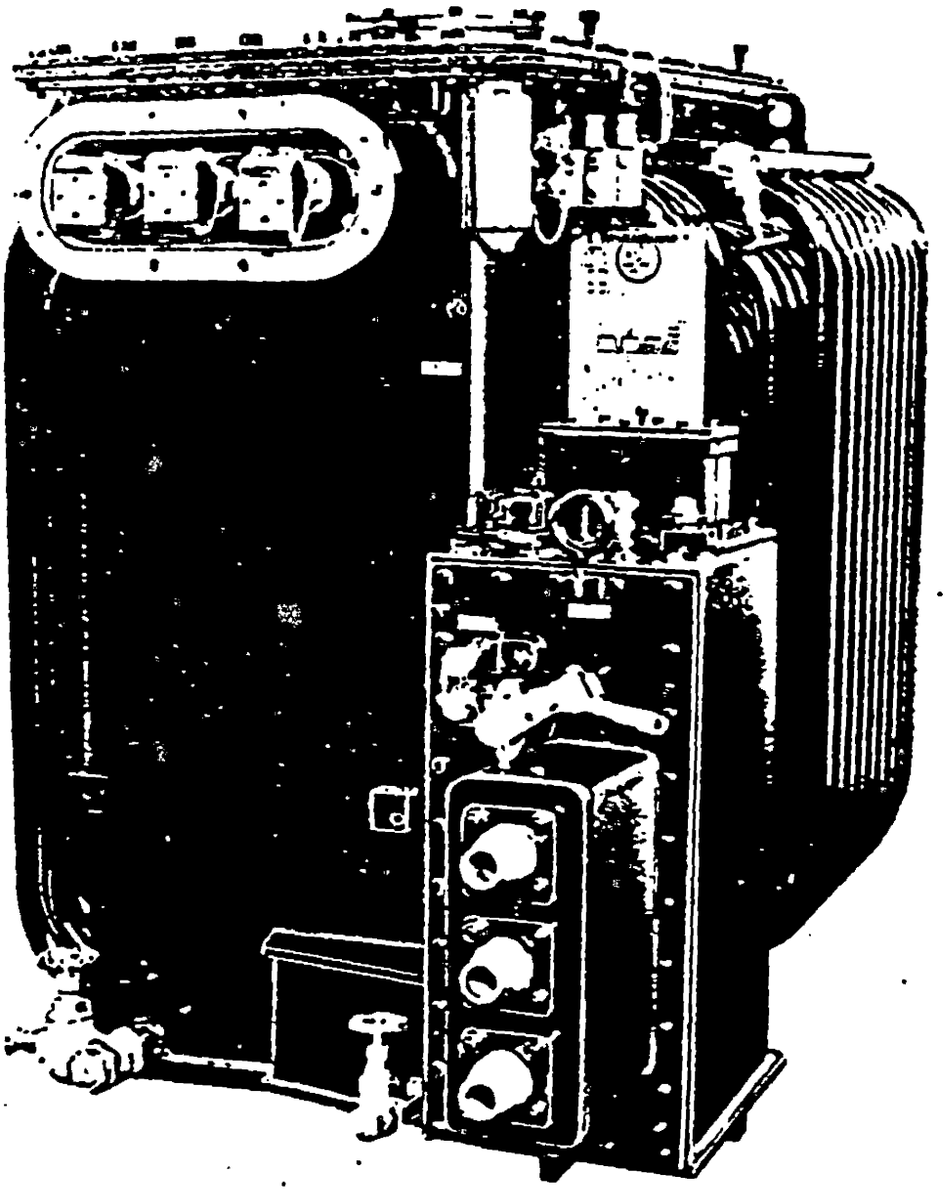

FIG. 1—800 KVA. INERTEEN TRANSFORMER

0854707

Westinghouse Electric & Manufacturing Company

Sharon Works

Sharon, Pa.

I. B. 5601
Filing No. 00-200

INDEX

INERTEEN

I N E R T E E N

Inerteen, developed by Westinghouse Engineers, is a synthetic non-inflammable and non-explosive insulating and cooling liquid used in Westinghouse Inerteen Transformers.

CHARACTERISTICS

Color	Straw-Yellow
Odor	Slightly Aromatic
Viscosity at 100°F. (Saybolt)	50 Seconds
Flash Point	None
Fire Point	None
Boiling Point	440°F.
Freezing Point	- 40°F.
Specific Gravity at 60°F.	1.555
Coefficient of Expansion per °C.	.00078
Specific Heat (Cal./cc)	.40
Dielectric Constant	4.42
Dielectric Strength	35 to 40 K.V.

Mineral oil is completely miscible with Inerteen. It is practically impossible to separate mineral oil and Inerteen; therefore, it is important to avoid contamination of Inerteen with any oil as the presence of such materials markedly changes the non-inflammable and non-explosive characteristics of Inerteen.

Inerteen is chemically stable. It is not affected by reaction with other materials used in the manufacture of Inerteen Transformers. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in transformers. Inerteen will not form sludge under any conditions.

Inerteen exerts a strong solvent action on most of the ordinary varnishes, gums and paints commonly used in oil-insulated transformers. Such meterials, therefore, cannot be used in the design and construction of Inerteen Transformers. It is necessary to use such materials as pure cellulose, cotton, paper and porcelain. This requirement, coupled with the necessary use of tight-tank construction for Inerteen Transformers tends to give improved operating characteristics.

If Inerteen is decomposed by an electric arc, hydrogen chloride gas is evolved. In case of arcing, the products of arc decomposition are definitely harmful and the Inerteen will have to be reconditioned. Where severe arcing occurs, the solid insulation of the transformer would become saturated with the products of arc decomposition and the affected parts must be removed from the transformers.

With reference to the dielectric strength of Inerteen it compares favorably with and under average normal conditions will be found higher than that of transformer oil. The same precautions are necessary with Inerteen as are taken with transformer oil. Inerteen should be kept free of moisture, lint and dirt.

INERTEEN

Inerteen has an irritating effect upon the skin. This is more pronounced to some persons than to others. Especially the eyes, nose and lips are affected when coming in contact with Inerteen and certain safety precautions must be observed when handling it. When working with the hands in Inerteen, it will irritate skin abrasions or the tender parts between the fingers. Continued exposure may cause skin eruptions with certain individuals due to absorption of the Inerteen through the pores of the skin. Cleanliness among workmen handling Inerteen is essential and a very good safeguard against such effects. An application of castor oil is recommended for the eyes and castor oil or cold cream for the nose and lips. In case Inerteen comes in contact with the skin, the part should be thoroughly washed and cleaned. A supply of these materials should be kept available at all times where men are working with Inerteen.

Hot transformers should not be opened except in well ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, it should be changed as soon as possible and the soiled clothing laundered before it is worn again. Special gloves, M-7530-6, which are resistant to Inerteen, should be worn where parts of transformers are handled wet.

SHIPMENT

Inerteen Transformers are always constructed in tight tanks which permit no breathing.

Inerteen Transformers are shipped properly filled with Inerteen and ready for installation. This prevents the entrance of moisture into the windings during transit and usually makes it unnecessary to dry the transformers prior to installation.

Transformers equipped with switch or terminal chamber which must be opened for installation, are always shipped with the Inerteen for these chambers in separate cans or steel drums.

Inerteen must always be kept in sealed containers to prevent the loss of its more volatile constituents by evaporation or possible contamination from dirt or moisture.

MOVING TRANSFORMERS

Lugs are provided for lifting the complete transformer, and when necessary, additional means are provided for lifting the different parts. The transformer should be lifted by the means provided and when necessary, spreaders should be used to obtain a balanced lift. Transformers should not be moved or lifted by placing jacks or other devices against or under cooling tubes, radiators, valves or other fittings. Skids should be used to distribute the stresses properly over the base when transformers are moved on rollers.

INSPECTION

Carefully inspect the transformers for possible damage during shipment.

This should include a check of the Inerteen level and at least the removal of the manhole to determine whether any parts have become loose or out of place and whether there is any evidence of moisture present. Insulation tests of the Inerteen should be made and if the dielectric strength is less than 22 K.V. or if there is any evidence of moisture, the transformer should be dried.

Inerteen Transformers are carefully tested at the Factory and in good condition when shipment is made but it is desirable to inspect every transformer carefully before placing it in service.

GROUNDING AND MAKING CONNECTIONS

No matter what the type of floor or foundation on which the transformer is to rest, the tank should be definitely and permanently grounded by connecting to the grounding connection provided for that purpose near the bottom of the tank.

Terminal board, tap changer and other connections should never be changed with voltage on the transformer. Do not make any connections except those indicated on the diagram or the diagram nameplate shipped with the transformer.

Any lead or connector not in use should be insulated from any other leads and connectors and from ground.

GASKETS

Gaskets used on Inerteen Transformers are made from a high grade cork and, it is recommended, in replacing any gaskets that they be made of cork. Before replacing a gasket, all gasket surfaces should be thoroughly cleaned free of rust, oil, grease, paint or other foreign materials. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with denatured alcohol.

Gasket Cement, M-7386, especially developed for use with Inerteen, should always be used in applying gaskets to Inerteen Transformers. Thoroughly brush the cement on the tank surface, place the gasket in position and apply weights or other means to obtain good adhesion of the gasket to the metal surface. The gasket should be allowed to set approximately one-half hour before the weights are removed. Cement M-7386 should then be applied to the top surface of the gasket. The gasket surfaces must immediately be bolted together under a uniform pressure.

Some transformers are equipped with terminal or switch compartments into which cables enter by means of potheads. In such cases, it will be necessary to remove the switch-cover.

When transformers are designed for bayonet connections, it is only necessary to remove the bayonet pothead, make the cable connections and replace the pothead.

Extra gaskets with Cement M-7386, are furnished with all Inerteen Transformers where their installation requires the removal of any gaskets. Additional gaskets and cement should be ordered from the manufacturer.

PIPE FITTINGS

Care should be used to see that threads of pipe fittings are not damaged. Their threads should be thoroughly cleaned to remove all dirt, grease, etc. After cleaning, apply Cement M-7386 to the threads of each fitting. Immediately screw the proper fittings together tightly.

PRESSURE TESTING

0854712

Inerteen Transformers should be pressure tested before they are put into service. The tanks, including all compartments, should be subjected to a pressure of 7 lbs. per square inch for

at least six hours. Preferably, this test should be made after the transformer installation is complete and before voltage is applied to it. It is suggested that the air space above the Inerteen be blown out by using a nitrogen-cylinder, after which all vents should be closed and the pressure test applied. The test-pressure, in order to avoid subjecting the tank or compartment under test to excessive pressure, can best be limited by a regulating valve on the nitrogen-cylinder. A check for leaks above the Inerteen level can be made with a solution of soap and water applied to all gasketed joints, pipe fittings and wiping sleeve connections.

PAINT

Inerteen Transformers are finished with a special paint which is resistant to the solvent action of Inerteen. A sufficient quantity of this paint, M-7664-1, is furnished with each transformer to "touch up" any damage caused during the normal process of installation.

STORAGE

Inerteen Transformers must always be stored filled with Inerteen, otherwise a certain amount of moisture will most certainly accumulate on account of variations of air temperature. The Inerteen level should always be checked to see that it is at the proper point. Inerteen Transformers should be stored in a dry place, one where minimum temperature changes will occur.

If there is any reason to store coils, insulation or other parts for the complete core and coil assembly of an Inerteen Transformer, they should be immersed in Inerteen to prevent any moisture absorption. If such storage is necessary for a long period of time, the tank or storage container must be sealed to prevent the evaporation of Inerteen.

Inerteen Transformers which have been idle or stored for an appreciable length of time, should be put into service only after making certain that the transformer is dry and that the dielectric strength of the Inerteen tests 22,000 volts or higher.

MAINTENANCE

Inerteen Equipment

Care must be exercised in handling Inerteen to prevent contamination since impurities alter its non-inflammable and electrical characteristics. It must be handled in thoroughly clean containers free from oil. If there is any question concerning the cleanliness of the containers, they should be thoroughly washed with Trichlorbenzene, M-6872, and dried before any Inerteen is place in them. The transformer tank or any of its compartments in which Inerteen is used, must be free from oil.

Inerteen should not be mixed with vegetable oils since these materials affect the deterioration, D.C. resistance and otherwise contaminate it. Compounds of asphaltic nature, paraffin and ordinary soldering flux are particularly harmful to Inerteen.

For soldering, a solution of rosin in alcohol is recommended.

All-metal hose must be used in handling Inerteen since the lining used in most hose is soluble in Inerteen.

Filling Inerteen Transformers

When it is necessary to fill a transformer with Inerteen, one should make sure that all joints are tight; Cement M-7386 should be used for this purpose. Steel pipe or metal hose should be used, and preferably the transformer should be filled through the drain valve. This will keep aeration of the Inerteen to a minimum. See that air vents are open as the transformer is filled.

It is desirable to fill a transformer by passing the Inerteen through an Inerteen Conditioner. If this cannot be done and the Inerteen tests satisfactorily, fill the transformer by passing the Inerteen through three thicknesses of tightly woven white cloth, which has first been washed in Trichlorbenzene M-6872, and dried to remove any sizing. New cloths should be used for at least every two transformers.

When it is necessary to fill Inerteen Transformers out-of-doors and particularly on damp days due precaution must be taken to prevent the entrance of moisture into the transformer.

PERIODIC INSPECTIONS

Inerteen - It is desirable that top and bottom samples of Inerteen be taken from each transformer and tested after a short period of operation. When operating conditions permit, routine sampling of the Inerteen at intervals of six months is recommended. Accurate records should be kept of such inspections and tests, and if the Inerteen shows a dielectric strength of less than 16 K.V., the Inerteen Conditioner may be used. This depends somewhat on the transformer load cycle and climatic conditions. If no facilities are available for making dielectric tests on Inerteen, samples should be sent to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna. Each sample of Inerteen should be properly identified by the transformer serial number and it should be recorded whether taken from the top or bottom of the tank or from a tank-compartment. Samples should be carefully packed to avoid breakage in transit. When any appreciable amount of Inerteen is removed from a transformer, it should be replaced with an equal amount of new Inerteen of proper dielectric strength so that the liquid level in the transformer is maintained.

INERTEEN TRANSFORMERS

Operation of Transformers - It is recommended that a periodic check be made of the operating temperatures of Inerteen transformers and that the temperature of the Inerteen be kept below 90°C. for a maximum-rated self-cooled transformer.

Paint - The external tank surfaces of Inerteen Transformers should be examined regularly for signs of corrosion. If appreciable corrosion is found, its cause should be determined and, if possible, remedied. Inerteen Transformer tanks are made from corrosion-resisting, copper-bearing steel, and they are finished with a high grade Inerteen-resisting paint which is baked on at high temperature. Any surface which is found corroded should be thoroughly cleaned to the bare metal and refinished with one coat of paint, M-6930, and two coats of paint, M-7664-1. Allow twelve hours drying time between each coat of paint.

TAKING SAMPLES OF INERTEEN

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for Inerteen Transformers be used for no other purpose. Care must be used in obtaining and sealing samples of Inerteen taken from a transformer.

Use only small tin containers with screw-metal gasket caps or small glass bottles with sealed glass stoppers for holding Inerteen samples.

If it becomes necessary to use other than Factory sampling containers, such containers should be thoroughly rinsed with clean gasoline, washed with strong soap suds and rinsed thoroughly in hot water, and then dried in an oven at approximately 110°C. for one hour. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

Inerteen sampling packages may be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. This package consists of two 1-pint cans of Inerteen, packed and shipped in cardboard cartons. This Inerteen may be used to replace that removed from a transformer as a sample. If samples are not taken immediately after emptying the containers, the empty containers should be kept capped snugly to prevent admittance of moisture. The containers and carton should be used to return the samples of Inerteen to the Westinghouse Company.

It is desirable that samples of Inerteen be removed from a transformer tank or from a drum on clear days only and when the Inerteen is at least as warm as the surrounding air.

The sample of Inerteen should preferably be removed from the top of the tank and at a point 2 or 3" under the level of the Inerteen. It is recommended that a sample be taken also from the

bottom of the tank. If the sample is withdrawn through a valve connection, this connection should be flushed by allowing a small amount of Inerteen to run out before collecting the sample. The sample should be immediately placed in the container and the cap screwed on tightly. The sticker on each container should be marked to identify the sample of Inerteen with the transformer from which it was taken.

Before taking samples from a drum, the Inerteen should be allowed to settle for approximately twelve hours. Samples from the top of the drum should be removed by means of a clean glass sneak-thief.

The same precautions to prevent moisture contamination should be used in sampling Inerteen as are observed in taking transformer oil samples.

The samples of Inerteen properly identified and packed in cardboard cartons should be shipped to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna.

DIELECTRIC TESTING OF INERTEEN

The same rules and precautions as normally followed in testing oil should be used in testing Inerteen, except as herein stated.

The test cup should be wiped clean with a clean, dry chamois and thoroughly rinsed with clean gasoline and allowed to dry before being used. The electrode spacing should be checked.

To determine whether the test cup is suitable for testing Inerteen, fill it with dry gasoline and test this under a standard voltage rise of 3 K.V. per second. If the dielectric strength of the gasoline is not less than 22 K.V., the test cup is suitable for testing Inerteen, after the cup has been dried in an oven to remove all traces of gasoline. Care should be exercised in handling gasoline. In testing, do not make but one "shot" per filling of the test cup. Five different fillings should be made and the average result used.

DRYING AND FILTERING INERTEEN

Inerteen may be dehydrated and filtered by means of an oil filter press but in order that it may not be contaminated, it is necessary that the filter press be used for Inerteen only.

A different procedure than that followed for oil is required to purify Inerteen. Contamination in Inerteen cannot be removed entirely by filter paper alone. To clean Inerteen thoroughly it must be filtered through "activated clay" which absorbs impurities. In practice, it is only necessary to pass the Inerteen through the clay and to separate the clay mechanically from the Inerteen to obtain clean Inerteen of proper dielectric strength.

THE INERTEEN CONDITIONER

The equipment recommended for conditioning Inerteen consists of a filter press with suitable inlet and outlet connections and the necessary fittings.

The clay is contained in five frames mounted in a yoke. Plates are used on both sides of these frames between which one piece of blotting paper is used to provide a gasket-seal and to remove fine particles of clay from the Inerteen.

The discharge in the plate incorporates a trap to avoid pumping into the transformer air which might result from a leak in the suction line. A strainer is provided on the suction side of the pump, so constructed that all dirt collected is removed with the screen. A by-pass connection fitted with a needle valve is used for testing the suction line from the transformer for leaks.

A pressure gage and a by-pass valve indicate the operation of the conditioner and they also serve as a check to avoid overloading and stalling the motor. The valve is set to by-pass the Inerteen at a pressure of 60 to 70 lbs. per square inch. Another pressure gage and by-pass valve are provided on the discharge side of the conditioner connecting to the transformer. This by-pass valve, releasing at a pressure of approximately 5 lbs. per square inch, will avoid breaking the transformer relief diaphragm when no other relief is provided.

TO PREPARE THE CONDITIONER FOR OPERATION

Release the pressure-screw and remove the frames. Fill each frame with activated clay, M-6934, to within 1/2" of the cover. Replace the frames in the conditioner, placing one sheet of "A" size blotting paper between the face of each frame and plate. Care should be used to see that the holes through the plates, frames and paper are in proper alignment before the pressure-screw is tightened. Close the discharge, suction and suction-test valves. Pour sufficient Inerteen into the drip pan to fill the conditioner and to wet the clay. This will require approximately 8 gallons of Inerteen. Start the motor and open the drip-pan valve so that not less than 5 minutes are required to fill the conditioner, saturating the clay with Inerteen. With the valve at the transformer closed, open the suction-test valve to check the suction line for leaks.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is therefore considered advisable to condition Inerteen from the top and return it to the bottom of the tank. To begin conditioning Inerteen in a transformer, close the suction-test valve and stop the motor. Open the transformer valves. Open the conditioner discharge and suction valves. Close the drip-pan valve and start the motor.

One charge of clay will condition approximately 3000 gallons of Inerteen, depending upon the amount of contamination present. To change the clay, remove the frames and turn them over to allow any free Inerteen to drain out of the openings at the top. Dump the used clay and fill the frames with fresh clay as previously described.

When it is necessary to change the blotters or the clay, first close the valve in the suction line, then stop the motor and close the discharge valve before releasing the pressure-screw. Follow the procedure outlined above when starting up the conditioner again.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to again resume conditioning the Inerteen.

TO DRY INERTEEN TRANSFORMERS

Inerteen Transformers above 100 Kv-a. should be dried by the short-circuit method with the transformer in its tank immersed in the Inerteen. During the heating and drying process, the top of the tank should be vented to the air to prevent moisture condensation. The desired load current should be obtained by short-circuiting one winding and impressing the proper voltage on the other winding. If the full load impedance of the transformer is not known or not engraved on the transformer nameplate, it should be obtained from the Westinghouse Electric & Manufacturing Company by identifying the transformer with its serial number.

Transformer windings in Inerteen should first be heated under a partial load. A higher top Inerteen temperature can be obtained more quickly by blanketing the tank with the cover removed to prevent condensation.

If the transformer is at or lower than room temperature at the start of the drying process, from 125% to 150% full load current will hasten the heating. The temperature should be carefully watched and when the Inerteen reaches a temperature of 60°C., the load should be reduced to obtain an approximately constant Inerteen temperature based on the following table. These temperatures should not be exceeded for a given load.

Short Circuit Amperes in Percent of Load	Max. Temperature of Top Inerteen
50	80
75	75
85	70

The transformer may be dried more quickly if it is possible to filter the Inerteen during the drying process. If the

filtering is continuous, care should be taken to avoid letting the Inerteen temperature become too low. If any moisture condenses on the underside of the cover, the temperature should be decreased until it stops, and it should not be increased again until after a period of time of approximately four to eight hours, depending upon the size of the transformer.

The drying should be continued until dielectric tests of samples of the Inerteen taken from the top and bottom of the tank show 22 K.V. or higher. The tests should be made in a standard test cup and it is recommended that at least two consecutive tests of both the top and bottom Inerteen be made at least 24 hours apart while the Inerteen is near a maximum temperature. Tests of the Inerteen should not be made during the filtering process.

DRYING TRANSFORMERS BY HOT AIR

Inerteen transformers may be dried by blowing clean, dry hot air through them. The air should be at a temperature of approximately 90°C. and it should be blown through the core and coils from the bottom of the transformer and allowed to pass out at the top. The amount of air required to dry the transformer must be such that the temperatures of the ingoing and outgoing air are approximately alike.

IF INERTEEN TRANSFORMERS FAIL IN SERVICE

Should an Inerteen transformer fail in service, the nearest W. E. & M. Company District Office should be notified as soon as possible. Give the rating of the transformer and its serial number and, if possible, the conditions under which the failure took place. Samples of the Inerteen should be taken so that an analysis of it can be made. The transformer should be kept immersed in Inerteen and it is recommended that no work be done on the transformer except under advice from the District Office.

ACCESSORIES FOR INERTEEN TRANSFORMERS

Pressure Relief Diaphragms - All transformers of ratings larger than 25 Kv-a., are furnished with pressure relief diaphragms. This device is made in different sizes to provide ample venting for different ratings.

Relief diaphragms are regularly supplied with covers arranged for a pipe connection to carry the gases to the outside atmosphere in case of a transformer failure and after the diaphragm ruptures. It is recommended that this type of installation be used for indoor transformers. For outdoor transformers, the relief device is regularly provided with a perforated outlet which allows the gases to escape directly to the outside atmosphere. The outlet is covered by a hood which prevents the entrance of moisture and dirt. A screen under the diaphragm prevents broken pieces from falling into the transformer.

The relief diaphragm unit assembly, which is bolted to the transformer cover or other suitable place, consists of a supporting flange in which the glass diaphragm is mounted between two cork gaskets. A tight joint between gasket and diaphragm on the supporting flange is made by a pressure-ring against the lower gasket, all of which is clamped in place by stud bolts.

It is necessary to be very careful in bolting down the pressure-ring to avoid breakage of the glass diaphragm for its rupture strength depends largely upon having an even distribution of clamping pressure applied to the diaphragm.

Make sure that gasket seats are thoroughly clean. Apply Cement M-7386 to both sides of the upper gasket and put the glass diaphragm in place, being sure that both the gasket and the diaphragm are centrally located in the supporting flange. Lay the cushion or lower gasket in place over the glass diaphragm and assemble the pressure-ring over this gasket. Then tighten the assembly by means of the nuts and lock washers on the stud bolts.

An even distribution of pressure on the glass diaphragm can be obtained only by tightening the nuts uniformly. This should be done by tightening alternate nuts until the lock washers are nearly compressed. The other nuts should then be tightened in a similar manner. This alternate nut tightening should be continued until the face of the pressure-ring is against the metal gasket-stop.

Diaphragm relief devices are assembled on the transformer at the factory and they are then pressure-tested at 7 lbs. per square inch and shipped in place.

Two spare diaphragms and the necessary gaskets and cement are shipped with each transformer. Additional diaphragms, if needed, should be ordered from the W. E. & M. Company, Sharon, Pennsylvania, identified by the serial number of the transformer.

Gas Absorbers for Inerteen Transformers - When Inerteen transformers are equipped with gas absorbers, separate instructions are shipped with each transformer describing the device and its installation, operation and maintenance.

RENEWAL PARTS

When information is required concerning a transformer, always give its serial number, particularly whenever renewal or stock parts are ordered. The serial number will be found engraved on the nameplate attached to the transformer tank and on the small nameplate attached to the top or end of the core and coils assembly. Whenever possible, a sketch showing the part or parts and their exact locations, will materially help to assure that the proper parts are supplied by the Factory.. This sketch should always indicate the direction or side of the transformer from which the view is made.

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NOTE: Some transformers are orderod designed for Inerteen but are to be operated first as oil-insulated transformers. Consequently, they are shipped from the factory filled with oil. Whenever it is desired to operate these transformers with Inerteen, complete instructions for the removal of the oil, the cleaning of the transformer and filling it with Inerteen should be obtained from the W. E. & M. Company, Sharon, Pennsylvania.

Westinghouse

INERTEEN TRANSFORMERS

Instruction Book

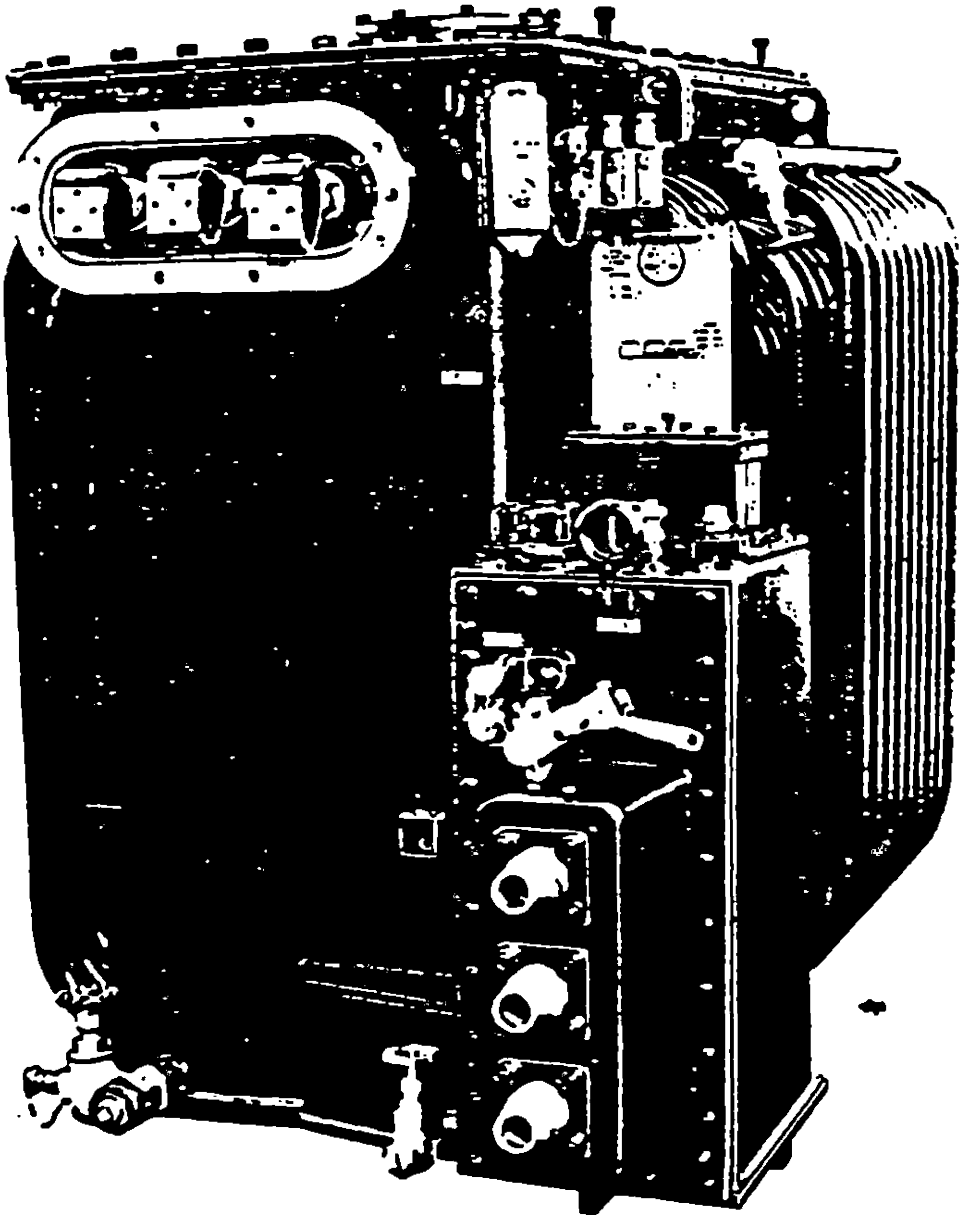

FIG. 1—500 KVA. INERTEEN TRANSFORMER

Westinghouse Electric & Manufacturing Company
Sharon Works, Sharon, Pa.

Printed in U.S.A. (Rep. 3-38)

I.B. 3802
Filing No. 00-200

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INERTEEN

INERTEEN

Inerteen, developed by Westinghouse Engineers, is a synthetic non-inflammable and non-explosive insulating and cooling liquid used in Westinghouse Inerteen Transformers.

Characteristics

Color	Straw-Yellow
Odor	Slightly Aromatic
Viscosity at 100°F. (Saybolt)	50 Seconds
Flash Point	None
Fire Point	None
Boiling Point	440°F.
Freezing Point	-40°F.
Specific Gravity at 60°F.	1.555
Coefficient of Expansion per °C.	.00078
Specific Heat (Cal./cc.	.40
Dielectric Constant	4.42
Dielectric Strength	35 to 40 K.V.

Mineral oil is completely miscible with Inerteen. It is practically impossible to separate mineral oil and Inerteen; therefore it is important to avoid contamination of Inerteen with any oil as the presence of such materials markedly changes the non-inflammable and non-explosive characteristics of Inerteen.

Inerteen is chemically stable. It is not affected by reaction with other materials used in the manufacture of Inerteen Transformers. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in transformers. Inerteen will not form sludge under any conditions.

Inerteen exerts a strong solvent action on most of the ordinary varnishes, gums and paints commonly used in oil-insulated transformers. Such materials, therefore, cannot be used in the design and construction of Inerteen Transformers. It is necessary to use such materials as pure cellulose, cotton, paper and porcelain. This requirement, coupled with the necessary use of tight-tank construction for Inerteen Transformers tends to give improved operating characteristics.

If Inerteen is decomposed by an electric arc, hydrogen chloride gas is evolved. In case of arcing, the products of arc decomposition are definitely harmful and the Inerteen will have to be reconditioned. Where severe arcing occurs, the solid insulation of the transformer would become saturated with the products of arc decomposition and the affected parts must be removed from the transformer.

With reference to the dielectric strength of Inerteen it compares favorably with and under average normal conditions will be found higher than that of transformer oil. The same precautions are necessary with Inerteen as are taken with transformer oil. Inerteen should be kept free of moisture, lint and dirt.

Inerteen has an irritating effect upon the skin. This is more pronounced to some persons than to others. Especially the eyes, nose and lips are affected when coming in contact with Inerteen and certain safety precautions must be observed when handling it. When working with the material in Inerteen, it will irritate skin abrasions or tender parts between the fingers. Continued exposure may cause skin erruptions with certain individuals due to absorption of the Inerteen through the pores of the skin. Cleanliness among workmen handling Inerteen is essential and a very good safeguard against such effects. An application of castor oil is recommended for the eyes and castor oil or cold cream for the nose and lips. In case Inerteen comes in contact with the skin, the part should be thoroughly washed and cleaned. A supply of these materials should be kept available at all times where men are working with Inerteen.

Hot transformers should not be opened except in well ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, it should be changed as soon as possible and the soiled clothing laundered before it is worn again. Special gloves, M-7530-6 which are resistant to Inerteen, should be worn where parts of transformers are handled wet.

INERTEEN TRANSFORMERS

Shipment

Inerteen Transformers are always constructed in tight tanks which permit no breathing.

Inerteen Transformers are shipped properly filled with Inerteen and ready for installation. This prevents the entrance of moisture into the windings during transit and usually makes it unnecessary to dry the transformers prior to installation.

Transformers equipped with switch or terminal chamber which must be opened for installation, are always shipped with the Inerteen for these chambers in separate cans or steel drums.

Inerteen must always be kept in sealed containers to prevent the loss of its more volatile constituents by evaporation or possible contamination from dirt or moisture.

Moving Transformers

Lugs are provided for lifting the complete transformer, and when necessary, additional means are provided for lifting the different parts. The transformer should be lifted by means provided and when

necessary, spreaders should be used to obtain a balanced lift. Transformers should not be moved or lifted by placing jacks or other devices against or under cooling tubes, radiators, valves or other fittings. Skids should be used to distribute the stresses properly over the base when transformers are moved on rollers.

INSPECTION

Carefully inspect the transformers for possible damage during shipment.

This should include a check of the Inerteen level and at least the removal of the manhole to determine whether any parts have become loose or out of place and whether there is any evidence of moisture present. Insulation tests of the Inerteen should be made and if the dielectric strength is less than 22 K.V. or if there is any evidence of moisture, the transformer should be dried.

Inerteen Transformers are carefully tested at the Factory and in good condition when shipment is made but it is desirable to inspect every transformer carefully before placing it in service.

Grounding and Making Connections

No matter what the type of floor or foundation on which the transformer is to rest, the tank should be definitely and permanently grounded by connecting to the grounding connection provided for that purpose near the bottom of the tank.

Terminal board, tap changer and other connections should never be changed with voltage on the transformer. Do not make any connections except those indicated on the diagram or the diagram nameplate shipped with the transformer.

Any lead or connector not in use should be insulated from any other leads and connectors and from ground.

Gaskets

Gaskets used on Inerteen Transformers are made from a high grade cork and, it is recommended, in replacing any gaskets that they be made of cork. Before replacing a gasket, all gasket surfaces should be thoroughly cleaned free of rust, oil, grease, paint or other foreign materials. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with denatured alcohol.

Gasket Cement, M-7386, especially developed for use with Inerteen, should always be used in applying gaskets to Inerteen Transformers. Thoroughly brush the cement on the tank surface, place the gasket in position and apply weights or other means to obtain good adhesion of the gasket to the metal surface. The gasket should be allowed to set approximately one-half hour before the weights are removed. Cement M-7386 should then be applied to the top surface of the gasket. The gasket surfaces must immediately be bolted together under a uniform pressure.

Some transformers are equipped with terminal or switch compartments into which cables enter by means of potheads. In such cases, it will be necessary to remove the switch-cover.

When transformers are designed for bayonet connections, it is only necessary to remove the bayonet pothead, make the cable connections and replace the pothead.

Extra gaskets with Cement M-7386, are furnished with all Inerteen Transformers where their installation requires the removal of any gaskets. Additional gaskets and cement should be ordered from the manufacturer.

Pipe Fittings

Care should be used to see that threads of pipe fittings are not damaged. Their threads should be thoroughly cleaned to remove all dirt, grease, etc. After cleaning, apply Cement M-7386 to the threads of each fitting. Immediately screw the proper fittings together tightly.

Pressure Testing

Inerteen Transformers should be pressure tested before they are put into service. The tanks, including all compartments, should be subjected to a pressure of 7 lbs. per square inch for at least six hours. Preferably, this test should be made after the transformer installation is complete and before voltage is applied to it. It is suggested that the air space above the Inerteen be blown out by using a nitrogen-cylinder, after which all vents should be closed and the pressure test applied. The test-pressure, in order to avoid subjecting the tank or compartment under test to excessive pressure, can best be limited by a regulating valve on the nitrogen-cylinder. A check for leaks above the Inerteen level can be made with a solution of soap and water applied to all gasketed joints, pipe fittings and wiping sleeve connections.

Paint

Inerteen Transformers are finished with a special paint which is resistant to the solvent action of Inerteen. A sufficient quantity of this paint, M-7664-1, is furnished with each transformer to "touch up" any damage caused during the normal process of installation.

Storage

Inerteen Transformers must always

be stored filled with Inerteen, otherwise a certain amount of moisture will most certainly accumulate on account of variations of air temperature. The Inerteen level should always be checked to see that it is at the proper point. Inerteen Transformers should be stored in a dry place, one where minimum temperature changes will occur.

If there is any reason to store coils, insulation or other parts for the complete core and coil assembly of an Inerteen Transformer, they should be immersed in Inerteen to prevent any moisture absorption. If such storage is necessary for a long period of time, the tank or storage container must be sealed to prevent the evaporation of Inerteen.

Inerteen Transformers which have been idle or stored for an appreciable length of time, should be put into service only after making certain that the transformer is dry and that the dielectric strength of the Inerteen tests 22,000 volts or higher.

Maintenance

Inerteen Equipment - Care must be exercised in handling Inerteen to prevent contamination since impurities alter its non-inflammable and electrical characteristics. It must be handled in thoroughly clean containers free from oil. If there is any question concerning the cleanliness of the containers, they should be thoroughly washed with Trichlorbenzene, M-6872, and dried before any Inerteen is placed in them. The transformer tank or any of its compartments in which Inerteen is used, must be free from oil.

Inerteen should not be mixed with vegetable oils since these materials affect the deterioration, D.C. resistance and otherwise contaminate it. Compounds of asphaltic nature, paraffin and ordinary soldering flux are particularly harmful to Inerteen.

For soldering, a solution of rosin in alcohol is recommended.

All-metal hose must be used in handling Inerteen since the lining used in most hose is soluble in Inerteen.

Filling Inerteen Transformers - When it is necessary to fill a transformer with Inerteen one should make sure that all joints are tight; Cement M-7386 should be used for this purpose. Steel pipe or metal hose should be used, and preferably the transformer should be filled through the drain valve. This will keep aeration of the Inerteen to a minimum. See that air vents are open as the transformer is filled.

It is desirable to fill a transformer by passing the Inerteen through an Inerteen Conditioner. If this cannot be done and the Inerteen tests satisfactorily, fill the transformer by passing the Inerteen through three thicknesses of tightly woven white cloth, which has first been washed in Trichlorbenzene M-6872, and dried to remove any sizing. New cloths should be used for at least every two transformers.

When it is necessary to fill Inerteen transformers out-of-doors and particularly on damp days due precaution must be taken to prevent the entrance of moisture into the transformer.

Periodic Inspections

Inerteen - It is desirable that top and bottom samples of Inerteen be taken from each transformer and tested after a short period of operation. When operating conditions permit, routine sampling of the Inerteen at intervals of six months is recommended.. Accurate records should be kept of such inspections and tests, and if the Inerteen shows a dielectric strength of less than 16 K.V., the Inerteen Conditioner may be used. This depends somewhat on the transformer load cycle and climatic conditions. If no facilities are available for making dielectric tests on Inerteen, samples should be sent to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna. Each sample of Inerteen should be properly identified by the transformer serial number and it should be recorded whether taken from the top or bottom of the tank or from a tank-compartment. Samples should be carefully packed to avoid breakage in transit. When any appreciable amount of Inerteen is removed from a transformer, it should be replaced with an equal amount of new Inerteen of proper dielectric strength so that the liquid level in the transformer is maintained.

Operation of Transformers - It is recommended that a periodic check be made of the operating temperatures of Inerteen transformers and that the temperature of the Inerteen be kept below 90°C. for a maximum-rated self-cooled transformer.

Paint - The external tank surfaces of Inerteen Transformers should be examined regularly for signs of corrosion. If appreciable corrosion is found, its cause should be determined and, if possible, remedied. Inerteen Transformer tanks are made from corrosion-resisting, copper-bearing steel, and they are finished with a high grade Inerteen-resisting paint which is baked on at high temperature. Any surface which is found corroded should be thoroughly cleaned to the bare metal and refinished with one coat of paint, M-6930, and two coats of paint, M-7664-1. Allow twelve hours drying time between each coat of paint.

Taking Samples of Inerteen

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for Inerteen Transformers be used for no other purpose. Care must be used in obtain-

ing and sealing samples of Inerteen taken from a transformer.

Use only small tin containers with screw-metal gasket caps or small glass bottles with sealed glass stoppers for holding Inerteen samples.

If it becomes necessary to use other than Factory sampling containers, such containers should be thoroughly rinsed with clean gasoline, washed with strong soap suds and rinsed thoroughly in hot water, and then dried in an oven at approximately 110°C. for one hour. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

Inerteen sampling packages S# 1065658 may be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. This package consists of two 1-pint cans of Inerteen, packed and shipped in cardboard cartons. This Inerteen may be used to replace that removed from a transformer as a sample. If samples are not taken immediately after emptying the containers, the empty containers should be kept capped snugly to prevent admittance of moisture. The containers and carton should be used to return the samples of Inerteen to the Westinghouse Company.

It is desirable that samples of Inerteen be removed from a transformer tank or from a drum on clear days only and when the Inerteen is at least as warm as the surrounding air.

The sample of Inerteen should preferably be removed from the top of the tank and at a point 2 or 3" under the level of the Inerteen. It is recommended that a sample be taken also from the bottom of the tank. If the sample is withdrawn through a valve connection, this connection should be flushed by allowing a small amount of Inerteen to run out before collecting the sample. The sample should be immediately placed in the container and the cap screwed on tightly. The sticker on each container should be marked to identify the sample of Inerteen with the transformer from which it was taken.

Before taking samples from a drum, the Inerteen should be allowed to settle for approximately twelve hours. Samples from the top of the drum should be removed by means of a clean glass sneak-thief.

The same precautions to prevent moisture contamination should be used in sampling Inerteen as are observed in taking transformer oil samples.

The samples of Inerteen properly identified and packed in cardboard cartons should be shipped to the Westinghouse Electric & Manufacturing Company, Sharon Works, Sharon, Penna.

Dielectric Testing of Inerteen

The same rules and precautions as normally followed in testing oil should be used in testing Inerteen, except as herein stated.

The test cup should be wiped clean with a clean, dry chamois and thoroughly rinsed with clean gasoline and allowed to dry before being used. The electrode spacing should be checked.

To determine whether the test cup is suitable for testing Inerteen, fill it with dry gasoline and test this under a standard voltage rise of 3 K.V. per second. If the dielectric strength of the gasoline is not less than 22 K.V. the test cup is suitable for testing Inerteen, after the cup has been dried in an oven to remove all traces of gasoline. Care should be exercised in handling gasoline. In testing, do not make but one "shot" per filling of the test cup. Five different fillings should be made and the average result used.

Drying and Filtering Inerteen

Inerteen may be dehydrated and filtered by means of an oil filter press but in order that it may not be contaminated, it is necessary that the filter press be used for Inerteen only.

A different procedure than that followed for oil is required to purify Inerteen. Contamination in Inerteen cannot be removed entirely by filter paper alone. To clean Inerteen thoroughly it must be filtered through "activated clay" which absorbs impurities. In practice, it is only necessary to pass the Inerteen through the clay and to separate the clay mechanically from the Inerteen to obtain clean Inerteen of proper dielectric strength.

The Inerteen Conditioner

The equipment recommended for conditioning consists of a filter press with suitable inlet and outlet connections and the necessary fittings.

The clay is contained in five frames mounted in a yoke. Plates are used on both sides of these frames between which one piece of blotting paper is used to provide a gasket-seal and to remove fine particles of clay from the Inerteen.

The discharge in the plate incorporates a trap to avoid pumping into the transformer air which might result from a leak in the suction line. A strainer is provided on the suction side of the pump, so constructed that all dirt collected is removed with the screen. A by-pass connection fitted with a needle valve is used for testing the suction line from the transformer for leaks.

A pressure gage and a by-pass valve indicate the operation of the conditioner and

they also serve as a check to avoid overloading and stalling the motor. The valve is set to by-pass the Inerteen at a pressure of 60 to 70 lbs. per square inch. Another pressure gage and by-pass valve are provided on the discharge side of the conditioner connecting to the transformer. This by-pass valve, releasing at a pressure of approximately 5 lbs. per square inch, will avoid breaking the transformer relief diaphragm when no other relief is provided.

To Prepare The Conditioner For Operation

Release the pressure-screw and remove the frames. Fill each frame with activated clay, M-6935, to within 1/2" of the cover. Replace the frames in the conditioner, placing one sheet of "A" size blotting paper between the face of each frame and plate. Care should be used to see that the holes through the plates, frames and paper are in proper alignment before the pressure-screw is tightened. Close the discharge, suction and suction-test valves. Pour sufficient Inerteen into the drip pan to fill the conditioner and to wet the clay. This will require approximately 8 gallons of Inerteen. Start the motor and open the drip pan valve so that not less than 5 minutes are required to fill the conditioner, saturating the clay with Inerteen. With the valve at the transformer closed, open the suction-test valve to check the suction line for leaks.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is therefore considered advisable to condition Inerteen from the top and return it to the bottom of the tank. To begin conditioning Inerteen in a transformer, close the suction test valve and stop the motor. Open the transformer valves. Open the conditioner discharge and suction valves. Close the drip pan valve and start the motor.

One charge of clay will condition approximately 3000 gallons of Inerteen, depending upon the amount of contamination present. To change the clay, remove the frames and turn them over to allow any free Inerteen to drain out of the openings at the top. Dump the used clay and fill the frames with fresh clay as previously described.

When it is necessary to change the blotters or the clay, first close the valve in the suction line, then stop the motor and close the discharge valve before releasing the pressure-screw. Follow the procedure outlined above when starting up the conditioner again.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to again resume conditioning the Inerteen.

To Dry Inerteen Transformers

Inerteen Transformers above 100 Kv-a. should be dried by the short-circuit method with the transformer in its tank immersed in the Inerteen. During the heating and drying process, the top of the tank should be vented to the air to prevent moisture condensation. The desired load current should be obtained by short-circuiting one winding and impressing the proper voltage on the other winding. If the full load impedance of the transformer is not known or not engraved on the transformer nameplate, it should be obtained from the Westinghouse Electric & Manufacturing Company by identifying the transformer with its serial number.

Transformer windings in Inerteen should first be heated under a partial load. A higher top Inerteen temperature can be obtained more quickly by blanketing the tank with the cover removed to prevent condensation.

If the transformer is at or lower than room temperature at the start of the drying process, from 125% to 150% full load current will hasten the heating. The temperature should be carefully watched and when the Inerteen reaches a temperature of 60°C., the load should be reduced to obtain an approximately constant Inerteen temperature based on the following table. These temperatures should not be exceeded for a given load

Short Circuit Amperes in Percent of Load	Max. Temperature of Top Inerteen
50	80
75	75
85	70

The transformer may be dried more quickly if it is possible to filter the Inerteen during the drying process. If the filtering is continuous, care should be taken to avoid letting the Inerteen temperature become too low. If any moisture condenses on the underside of the cover, the temperature should be decreased until it stops, and it should not be increased again until after a period of time of approximately four to eight hours, depending upon the size of the transformer.

The drying should be continued until dielectric tests of samples of the Inerteen taken from the top and bottom of the tank show 22 K.V. or higher. The tests should be made in a standard test cup and it is recommended that at least two consecutive tests of both the top and bottom Inerteen be made at least 24 hours apart while the Inerteen is near a maximum temperature. Tests of the Inerteen should not be made during the filtering process.

Drying Transformers by Hot Air

Inerteen transformers may be dried by blowing clean, dry hot air through them. The air should be at a temperature of approximately 90°C.

and it should be blown through the core and coils from the bottom of the transformer and allowed to pass out at the top. The amount of air required to dry the transformer must be such that the temperatures of the ingoing and outgoing air are approximately alike.

If Inerteen Transformers Fail in Service

Should an Inerteen transformer fail in service, the nearest W. E. & M. Company District Office should be notified as soon as possible. Give the rating of the transformer and its serial number and, if possible, the conditions under which the failure took place. Samples of the Inerteen should be taken so that an analysis of it can be made. The transformer should be kept immersed in Inerteen and it is recommended that no work be done on the transformer except under advice from the District Office.

Accessories for Inerteen Transformers

Pressure Relief Diaphragms - All transformers of ratings larger than 25 Kv-a., are furnished with pressure relief diaphragm. This device is made in different sizes to provide ample venting for different ratings.

Relief diaphragms are regularly supplied with covers arranged for a pipe connection to carry the gases to the outside atmosphere in case of a transformer failure and after the diaphragm ruptures. It is recommended that this type of installation be used for indoor transformers. For outdoor transformers, the relief device is regularly provided with a perforated outlet which allows the gases to escape directly to the outsied atmosphere.. The outlet is covered by a hood which prevents the entrance of moisture and dirt. A screen under the diaphragm prevents broken pieces from falling into the transformer.

The relief diaphragm unit assembly, which is bolted to the transformer cover or other suitable place, consists of a supporting flange in which the glass diaphragm is mounted between two cork gaskets. A tight joint between gasket and diaphragm on the supporting flange is made by a pressure ring against the lower gasket, all of which is clamped in place by stud bolts.

It is necessary to be very careful bolting down the pressure-ring to avoid breakage of the glass diaphragm for its rupture strength depends largely upon having an even distribution of clamping pressure applied to the diaphragm.

Make sure that gasket seats are thoroughly clean. Apply Cement M-7386 to both sides of the upper gasket and put the glass diaphragm in place, being sure that both the gasket and the diaphragm are centrally located in the supporting flange. Lay the cushion or lower gasket in place over the glass diaphragm and assemble the pressure ring over this gasket. Then tighten the assembly by means of the nuts and lock washers on the stud bolts.

An even distribution of pressure on the glass diaphragm can be obtained only by tightening the nuts uniformly. This should be done by tightening alternate nuts until the lock washers are nearly compressed. The other nuts should then be tightened in a similar manner. This alternate nut tightening should be continued until the face of the pressure-ring is against the metal gasket-stop.

Diaphragm relief devices are assembled on the transformer at the factory and they are then pressure-tested at 7 lbs. per square inch and shipped in place.

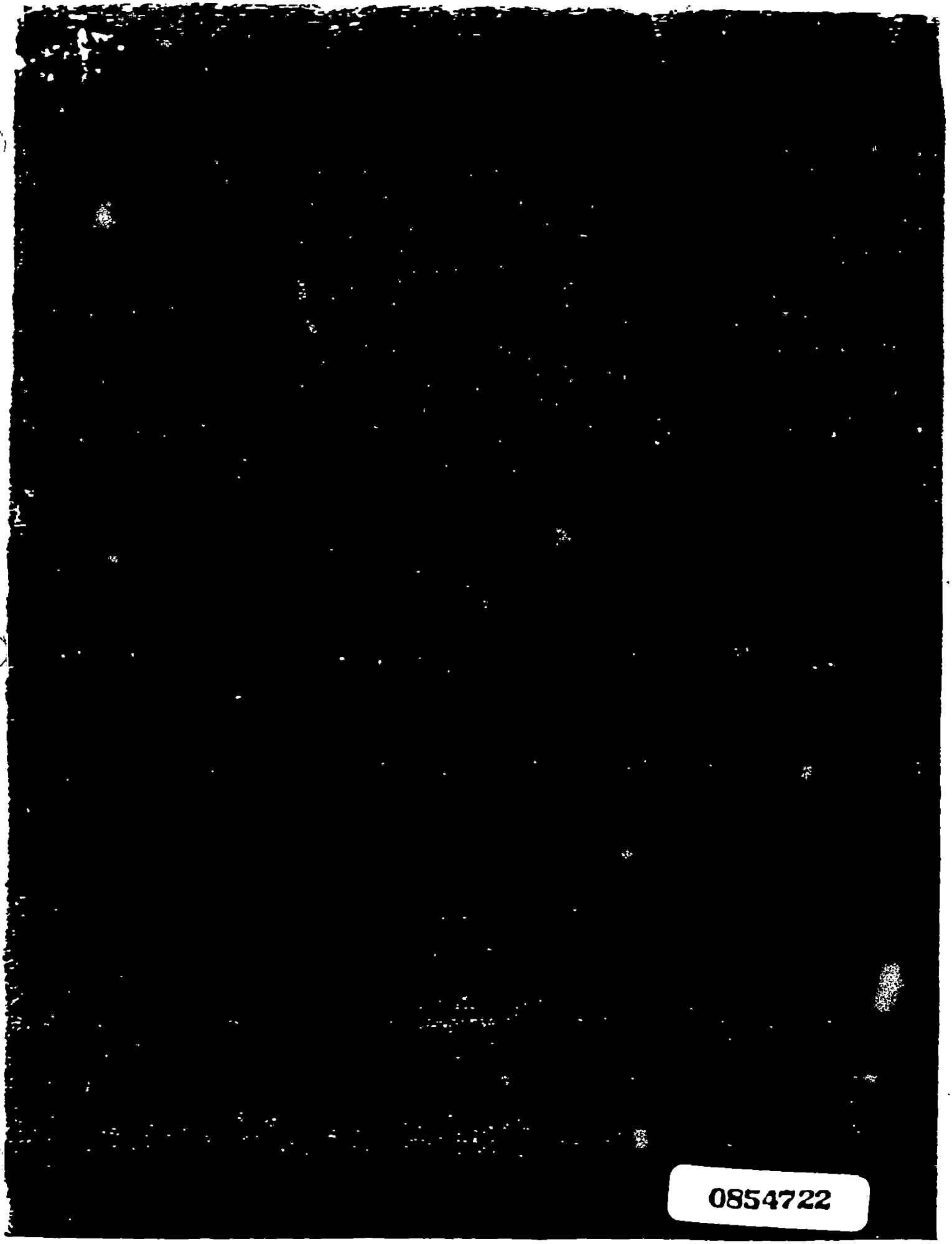
Two spare diaphragms and the necessary gaskets and cement are shipped with each transformer. Additional diaphragms, if needed, should be ordered from the W. E. & M. Company, Sharon, Pennsylvania, identified by the serial number of the transformer.

Gas Absorbers for Inerteen Transformers-- When Inerteen transformers are equipped with gas absorbers, separate instructions are shipped with each transformer describing the device and its installation, operation and maintenance.

Reneval Parts

When information is required concerning a transformer, always give its serial number particularly whenever reneval or stock parts are ordered. The serial number will be found engraved on the nameplate attached to the transformer tank and on the small nameplate attached to the top or end of the core and coils assembly. Whenever possible, a sketch showing the part or parts and their exact locations, will materially help to assure that the proper parts are supplied by the Factory. This sketch should always indicate the direction or side of the transformer from which the view is made.

NOTE: Some transformers are ordered designed for Inerteen but are to be operated first as oil-insulated transformers. Consequently, they are shipped from the factory filled with oil. Whenever it is desired to operate these transformers with Inerteen, complete instructions for the removal of the oil, the cleaning of the transformer and filling it with Inerteen should be obtained from the W. E. & M. Company, Sharon, Pennsylvania.



Westinghouse Exhibit 3

INDEX

INERTEEN

Inerteen is a synthetic non-inflammable and non-explosive insulating and cooling liquid used in Westinghouse Inerteen Transformers.

Characteristics

Color	Straw Yellow
Viscosity at 100°F. (Sayboit).	54 Seconds
Fire Point	None
Specific Gravity at 60°F.	1.564
Dielectric Constant	4.5

Mineral oil is completely miscible with transformer Inerteen. It is practically impossible to separate mineral oil and Inerteen; therefore it is important to avoid contamination of Inerteen with any oil as the presence of such materials markedly changes the non-inflammable and non-explosive characteristics of Inerteen.

Inerteen is chemically stable. It is not affected by reaction with other materials used in the manufacture of Inerteen Transformers. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in transformers. Inerteen will not form sludge under any conditions.

Inerteen exerts a strong solvent action on most of the ordinary varnishes, gums and paints commonly used in oil-insulated transformers. Such materials, therefore, are not used in the design and construction of Inerteen Transformers. It is necessary to use such materials as pure cellulose, cotton, paper and porcelain. This requirement, coupled with the necessary use of tight-tank construction for Inerteen Transformers tends to give improved operating characteristics. The operating experience with Inerteen Transformers indicates that Inerteen requires less maintenance than oil.

If Inerteen is decomposed by an electric arc, hydrogen chloride gas is evolved. The products of arc decomposition are harmful to the transformer structure. Where severe arcing occurs, the solid insulation of the transformer becomes saturated with hydrogen chloride and the affected parts must be removed in the repair of the transformer.

The dielectric strength of Inerteen compares favorably with and under average normal conditions will be found higher than that of transformer oil. The same precautions are necessary with Inerteen as are taken with transformer oil. Inerteen should be kept free of moisture, lint and dirt.

Inerteen has an irritating effect upon the skin. This is more pronounced to some persons than to others. Especially the eyes, nose and lips are affected when coming in contact with Inerteen and certain safety precautions must be observed when handling it. When working with the hands in Inerteen, it will irritate skin abrasions or the tender parts between the fingers. Continued exposure may cause skin eruptions with certain individuals due to absorption of the Inerteen through the pores of the skin. Cleanliness among workmen handling Inerteen is essential and a very good safeguard against such effects. An application of castor oil is recommended for the eyes and castor oil or cold cream for the nose and lips. In case Inerteen comes in contact with the skin, the part should be thoroughly washed and cleaned. A supply of these materials should be kept available at all times where men are working with Inerteen.

Hot transformers should not be opened except in well ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, it should be changed as soon as possible and the soiled clothing laundered before it is worn again. Gloves, S#1184650, which are resistant to Inerteen, should be worn where it is necessary to put one's hand in Inerteen or where parts of transformers are handled wet.

INERTEEN TRANSFORMERS

Shipment

Inerteen Transformers are always constructed in pressure-tight tanks.

Inerteen transformers are shipped properly filled with Inerteen and ready for installation. This prevents the entrance of moisture into the windings during transit and usually makes it unnecessary to dry the transformers prior to installation.

Transformers equipped with switch or terminal chambers which must be opened for installation, are shipped with the Inerteen for these chambers in separate containers.

A small amount of moisture will reduce the dielectric strength of Inerteen. It may be present in vapor form in the gas space above the Inerteen level or from minute leaks.

Activated clay has a high affinity for moisture and absorbs other materials which may contaminate Inerteen. To keep the Inerteen in the best condition, bonded tubes of activated clay are installed and shipped in place in switch and terminal chambers of new transformers. When the Inerteen is shipped in separate containers the tubes are also shipped separately, enclosed in air-tight containers.

Inerteen must always be kept in sealed containers to prevent the loss of its more volatile constituents by evaporation or possible contamination from dirt or moisture.

Moving Transformers

Lugs are provided for lifting the complete transformer, and when necessary, additional means are provided for lifting the different parts. The transformer should be lifted by the means provided and when necessary, spreaders should be used to obtain a balanced lift. Transformers should not be moved or lifted by placing jacks or other devices against or under cooling tubes, radiators, valves or other fittings. Skids should be used to distribute the stresses properly over the base when transformers are moved on rollers.

Inspection

Carefully inspect the transformers for possible damage during shipment.

This should include a check of the Inerteen level and at least the removal of the manhole cover to determine whether any parts have become loose or out of place and whether there is any evidence of moisture present. Insulation tests of the Inerteen should be made and if the dielectric strength is less than 22 KV or if there is any evidence of moisture, the transformer should be dried.

Where transformers are to be used at high altitude (more than 3000 ft. 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. Be sure that the fitting is closed after equalizing the pressure.

All transformers are carefully tested at the Factory and in good condition when shipment is made but it is desirable to inspect each transformer thoroughly before placing it in service.

Grounding and Making Connections

No matter what the type of floor or foundation on which the transformer is to rest, the tank should be definitely and permanently grounded by connecting a lead to the grounding connection provided for that purpose near the bottom of the tank.

Terminal board, tap changer and other connections should never be changed with voltage on the transformer. Do not make any connections except those indicated on the diagram or the diagram nameplate shipped with the transformer.

Any lead or connector not in use should be insulated from all other leads and connectors and from ground.

Gaskets

Gaskets used on Inerteen Transformers are made from a high grade of cork and, it is recommended, in replacing any gaskets that they be made of cork. Before replacing a gasket, all gasket surfaces should be thoroughly cleaned free of rust, oil, grease, paint or other foreign materials. The cleaning may be done by scraping or wire-brushing and then wiping the gasket surface with denatured alcohol.

Gasket Cement S#471880* especially developed for use with Inerteen, should always be used in applying gaskets. Thoroughly brush the cement on the tank surface and on the bottom side of the gasket. Place the gasket in position and apply weights or other means to obtain good adhesion of the gasket to the metal surface. The gasket should be allowed to set approximately one-half hour before the weights are removed. Cement should then be applied to the top surface of the gasket. The gasket surfaces must immediately be bolted together under a uniform pressure.

Transformers are frequently equipped with terminal or switch compartments into which cables enter by means of potheads. In some cases, it will be necessary to remove the switch-cover to make the cable connections.

When transformers are designed for bayonet connections, it is only necessary to remove the bayonet pothead, make the cable connections and replace the pothead.

Extra gaskets and Cement S#471880 are furnished with all Inerteen Transformers where their installation requires the removal of any gaskets. Additional gaskets and cement should be ordered from the manufacturer.

Pipe Fittings

Care should be taken to see that threads of pipe fittings are not damaged. All threads should be thoroughly cleaned to remove dirt, grease, etc. After cleaning, apply Cement S# 471880 to the threads of each fitting. Immediately screw the proper fittings together tightly.

Pressure Testing

All Inerteen transformers are pressure tested at the factory and shipped free of leaks. After installation 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 the installation. Dry compressed nitrogen or air should be used at a test pressure of 7 lbs. per square inch for a period of six hours. It is suggested that the air space above the Inerteen be blown out with nitrogen, all vents closed and the pressure test applied. The test pressure can best be limited by the use of a regulating valve on the nitrogen cylinder. A check for leaks above the Inerteen level may be made with a solution of soap and water applied to all gasketed-joints, screwed-fittings and wiping-sleeve connections.

Paint

Inerteen Transformers are finished with a special paint, which is resistant to the solvent action of Inerteen. A sufficient quantity of this paint S#302509 is furnished with each transformer to "touch up" any places damaged during the process of installation.

Storage

Inerteen Transformers must always be stored filled to the proper level with Inerteen, otherwise a certain amount of moisture may accumulate on account of variations of air temperature. Inerteen Transformers should be stored in a dry place, and where minimum temperature changes will occur.

Where it is necessary to temporarily store coils, insulation or other parts for the complete core and coil assembly of an Inerteen Transformer, they should be immersed in Inerteen to prevent moisture absorption. If such storage is necessary for a long period of time, the tank or storage container must be sealed to prevent the entrance of moisture and the evaporation of Inerteen.

Inerteen Transformers which have been idle or stored for an appreciable length of time, should be put into service only after making cer-

*Quart Can.

tain that the transformer is dry and that the dielectric strength of the Inerteen tests 22,000 volts or higher. The inspection instructions should also be followed.

Maintenance

Inerteen Equipment - Care must be exercised in handling Inerteen to prevent contamination since impurities alter its non-inflammable and electrical characteristics. It must be handled in thoroughly clean containers free from oil. If there is any question concerning the cleanliness of the containers, they should be thoroughly washed with Trichlorbenzene M-6872 and dried before any Inerteen is placed in them. The transformer tank or any of its compartments in which Inerteen is used, must be free from oil and other contaminating materials.

Inerteen should not be mixed with vegetable oils since these materials affect the deterioration, D.C. resistance and otherwise contaminate it. Compounds of asphaltic nature, paraffin and ordinary soldering flux are particularly harmful to Inerteen.

For soldering, a solution of rosin in alcohol is recommended.

All-metal hose must be used in handling Inerteen since the lining used in most hose is soluble in Inerteen.

Filling Transformers - When it is necessary to fill a transformer with Inerteen one should make sure that all joints are tight; Cement S#471880 should be used for this purpose. Steel pipe or metal hose should be used, and preferably the transformer should be filled through the drain valve. This will keep aeration of the Inerteen to a minimum. See that air vents are open as the transformer is filled.

It is desirable to fill a transformer by passing the Inerteen through an Inerteen Conditioner. If this cannot be done and the Inerteen tests satisfactorily, fill the transformer by passing the Inerteen through three thicknesses of tightly woven white cloth, which has first been washed in Trichlorbenzene and dried to remove any sizing. New cloths should be used for at least every two transformers.

When it is necessary to fill Inerteen transformers out-of-doors and particularly on damp days due precaution must be taken to prevent the entrance of moisture into the transformer.

Filling Switch and Terminal Chambers - Care should be exercised when filling switch and terminal chambers with Inerteen, and during servicing to avoid contamination by moisture or dirt, which may lower the dielectric strength of the Inerteen. The moisture may be present during the filling operation due to condensation and absorption on the inside of the chamber walls, or may appear as vapor in the gas space above the Inerteen or from any minute leaks.

The use of bonded tubes of activated clay in Inerteen-filled chambers of transformers in service is recommended where routine tests show the Inerteen to have unsatisfactory dielectric strength.

The tubes should not be removed from their containers until the terminal chamber is ready for their installation. The tubes should not be exposed to air more than approximately thirty minutes before closing up the chamber preparatory to filling it with Inerteen unless they are first dried for two hours at a temperature of approximately 250°C. or for twelve hours at 135 to 150°C.

If it becomes necessary to drain the Inerteen or to open the chamber after a period of service, it is recommended that new tubes be installed. To do this, it is only necessary to remove the bolts holding the spring clips, remove the old and insert the new tubes, and replace the clips and bolts.

When an Inerteen Conditioner is not available for use in filling chambers with Inerteen, it is recommended that the Inerteen be strained through two or three layers of tightly woven white cloth and poured through a container in which three or four clay tubes have been broken into small pieces. This will materially reduce the possibility of contamination of the Inerteen from dirt and moisture.

Bonded clay tubes should be ordered as Style #1150140 from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. It is also desirable when ordering new tubes to identify the transformer for which they are required by including the serial number of the transformer.

Periodic Inspections

Inerteen - It is desirable that top and bottom samples of Inerteen be taken from each transformer and tested after a short period of operation. When operating conditions permit, routine sampling of the Inerteen at intervals of six months is recommended. Accurate records should be kept of such inspections and tests, and if the Inerteen shows a dielectric strength of less than 16 KV the Inerteen Conditioner may be used. This depends somewhat on the transformer load cycle and climatic conditions. If no facilities are available for making dielectric tests on Inerteen, samples should be sent to the Westinghouse Electric & Manufacturing Company, Sharon, Penna. Each sample of Inerteen should be properly identified by the transformer serial number and it should be recorded whether taken from the top or bottom of the tank or from a tank-compartment. Samples should be carefully packed to avoid breakage in transit. When any appreciable amount of Inerteen is removed from a transformer, it should be replaced with an equal amount of new Inerteen of proper dielectric strength so that the liquid level in the transformer is maintained.

Operation of Transformers - It is recommended that a periodic check be made of the operating temperatures of Inerteen transformers and that the temperature of the Inerteen be kept below 90°C. for a maximum-rated self-cooled transformer.

Paint - The external tank surfaces of Inerteen Transformers should be examined regularly for signs of corrosion. If appreciable corrosion is found, its cause should be determined and, if possible, remedied. Inerteen Transformer tanks are made from corrosion-resis-

ting, copper-bearing steel, and they are finished with a high grade Inerteen-resisting paint which is baked on at high temperature. Any surface which is found corroded should be thoroughly cleaned to the bare metal and refinished with one coat of primer, and two coats of finish paint S#302509. Allow twelve hours drying time between each coat of paint.

Taking Samples of Inerteen

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for Inerteen Transformers be used for no other purpose. Care must be used in obtaining and sealing samples of Inerteen taken from a transformer.

Use only small tin containers with screwed metal-gasket caps or small glass bottles with glass stoppers for holding Inerteen samples.

If it becomes necessary to use other than Factory sampling containers, such containers should be thoroughly rinsed with clean gasoline, washed with strong soap suds and rinsed thoroughly in hot water, and then dried in an oven at approximately 110°C. for one hour. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

Inerteen sampling package S# 1065658 may be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. This package consists of four 1-pint cans of Inerteen, packed and shipped in cardboard cartons. This Inerteen may be used to replace that removed from a transformer as a sample. If samples are not taken immediately after emptying the containers, the empty containers should be tightly capped to prevent admittance of moisture.

It is desirable that samples of Inerteen be removed from a transformer tank or from a drum on clear days only and when the Inerteen is at least as warm as the surrounding air.

The sample of Inerteen should be removed near the surface of the fluid. This can be done readily through the rotary sampling device and valve. It is also recommended that a sample be taken from the bottom of the tank, particularly from the bottom of switch or terminal-chambers. If the sample is withdrawn through a valve connection, this connection should be flushed by allowing a small amount of Inerteen to run out before collecting the sample. The sample should be immediately placed in the container and the cap screwed on tightly. The sticker on each container should be marked to identify the sample of Inerteen with the transformer from which it was taken and whether taken from the top or bottom.

Before taking samples from a drum, the Inerteen should be allowed to settle for approximately twelve hours. Samples from the top of the drum should be removed by means of a clean glass sneak-thief.

The same precautions to prevent moisture contamination should be used in sampling Inerteen as are observed in taking transformer oil samples. Sampling equipment should be used only for Inerteen.

Dielectric Testing of Inerteen

The same rules and precautions as normally followed in testing oil should be used in testing Inerteen, except as herein stated.

The test cup should be wiped with a clean, dry chamois and thoroughly rinsed with clean gasoline and allowed to dry before being used. The electrode spacing should be checked.

To determine whether the test cup is suitable for testing Inerteen, fill it with dry gasoline and test this under a standard voltage rise of 3 KV per second. If the dielectric strength of the gasoline is not less than 22 KV, the test cup is suitable for testing Inerteen, after the cup has been dried in an oven where the temperature does not exceed 50°C. to remove all traces of gasoline. Care should be exercised in handling gasoline as it is highly inflammable. In testing Inerteen, make only one "shot" per filling of the test cup. Five different fillings should be made and the average result used.

Drying and Filtering Inerteen

Inerteen may be dehydrated and filtered by means of an oil filter press but in order that it may not be contaminated, it is necessary that the filter press be used for Inerteen only.

A different procedure than that followed for oil is required to purify Inerteen. Contamination in Inerteen cannot be removed entirely by filter paper alone. To clean Inerteen thoroughly it must be filtered through "activated clay" which absorbs impurities. In practice, it is only necessary to pass the Inerteen through the clay and to separate the clay mechanically from the Inerteen to obtain clean Inerteen of proper dielectric strength.

The Inerteen Conditioner

The equipment recommended for conditioning Inerteen consists of an activated clay chamber and filter press with suitable inlet and outlet connections and other necessary fittings.

The activated clay is contained in a tank mounted on one end of the filter press. The Inerteen is pumped up through the clay insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through a wire screen prior to entering the filter press to remove practically all of the clay.

The cover of the tank incorporates an air-trap and vent to avoid pumping air into the transformer which might result from a leak in the suction line. A strainer is provided on the suction side of the pump, so constructed that all dirt collected is removed with the screen. A by-pass connection fitted with a needle valve is used for testing the suction line from the transformer for leaks.

The filter press consists of 15 frames and 16 plates alternately spaced mounted in a yoke. One sheet of blotting paper is used between each plate and frame to provide a gasket-seal and to remove all traces of clay from the Inerteen.

A pressure gage indicates the operation and two by-pass valves assure safe operation of the Conditioner by preventing excessive pressures and serve as a check to overloading and stalling the motor. One valve, connected across the pump, is set to by-pass the Inerteen at a pressure of 60 to 70 lbs. per square inch. The other valve is provided on the discharge side of the Conditioner connecting to the transformer. This by-pass valve, releasing at a pressure of approximately 5 lbs. per square inch, will avoid breaking the transformer relief diaphragm when no other relief is provided.

To Prepare the Conditioner for Operation

Remove the cover and screen from the clay tank and fill the tank with activated clay, M-6934 to within four inches of the bottom edge on the inner flange. Replace screen and cover. Release the pressure-screw of the filter press and loosen plates and frames. Place one sheet of "B" size blotting paper between the face of each frame and plate. Care should be used to see that the holes through the plates, frames and paper are in proper alignment before the pressure-screw is tightened. Close the discharge, tank by-pass, tank drain, suction and suction-test valves. Pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons of Inerteen. Start the motor and open the drip pan valve so that not less than 5 minutes are required to fill the clay tank, saturating the clay with Inerteen. With the valve at the transformer closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is therefore considered advisable to condition Inerteen from the top and return it to the bottom of the tank. To begin conditioning Inerteen in a transformer, close the suction test valve and stop the motor. Open the transformer valves. Open the Conditioner discharge and suction valves. Close the drip pan valve and start the motor.

One charge of clay will condition approximately 3000 gallons of Inerteen, depending upon the amount of contamination present.

When it is necessary to change the clay, first close the valve in the suction line, close the tank inlet and outlet valves, open the tank by-pass valve and tank drain valve to permit the free Inerteen in the tank to drain into the lower drip pan. Open the drip pan valve and pump the Inerteen from the drip pan through the filter press. Additional Inerteen may be forced out of the clay by applying air pressure to the air vent. Shut down the motor and remove the clay from the tank and refill with fresh clay as previously described.

To change the filter or blotting papers, stop the motor, close the tank by-pass valve, the tank inlet valve and the tank drain valve, if these valves are open. Open the tank outlet valve and apply air pressure to the air vent until the free Inerteen has been driven out of the blotting papers. Then release the pressure-screw and remove the papers.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to again resume conditioning the Inerteen.

To Dry Inerteen Transformers

Inerteen Transformers should be dried by the short-circuit method with the transformer in its tank immersed in the Inerteen. During the heating and drying process, the top of the tank should be vented to the air to prevent moisture condensation. The desired load current should be obtained by short-circuiting one winding and impressing the proper voltage on the other winding. If the full load impedance of the transformer is not known or not engraved on the transformer nameplate, it should be obtained from the Westinghouse Electric & Manufacturing Company by identifying the transformer with its serial number.

Transformer windings in Inerteen should first be heated under a partial load. A higher top Inerteen temperature can be obtained more quickly by blanketing the tank with the cover removed to prevent condensation.

If the transformer is at or lower than room temperature at the start of the drying process, from 125% to 150% full load current will hasten the heating. The temperature should be carefully watched and when the Inerteen reaches a temperature of 60°C., the load should be reduced to obtain an approximately constant Inerteen temperature based on the following table. These temperatures should not be exceeded for a given load.

Short Circuit Amperes in Percent of Load	Max. Temperature of Top Inerteen
50	80
75	75
85	70

The transformer may be dried more quickly if it is possible to filter the Inerteen during the drying process. If the filtering is continuous, care should be taken to keep the Inerteen temperature above 60°C. If moisture condenses on the undersides of the cover, the rate of temperature rise should be decreased until condensation ceases. To prevent condensation the tank temperature may be raised by blanketing the tank.

The drying should be continued until dielectric tests of samples of the Inerteen taken from the top and bottom of the tank show 22 KV or higher. The tests should be made in a standard test cup and it is recommended that at least two consecutive tests of both the top and bottom Inerteen be made at least 24 hours apart while the Inerteen is near a maximum temperature. Tests of the Inerteen should not be made during the filtering process.

If Transformers Fail in Service

Should an Inerteen Transformer fail in service, the nearest Westinghouse Electric & Manufacturing Company District Office should be notified as soon as possible. Give the rating of the transformer and its serial number and, if possible, the conditions under which the failure took place. Samples of the Inerteen should be taken so that an analysis of it can be made. The transformer should be kept immersed in Inerteen and it is recommended that no work be done on the transformer except under advice from the District Office.

Accessories for Inerteen Transformers

Pressure Relief Diaphragms - All transformers above 25 KVA are furnished with a pressure relief diaphragm. Fig. #1 shows a sectional view. This device is made in different sizes to provide ample venting for different ratings.

Relief diaphragms are regularly supplied, arranged so that a flange with the necessary piping may be applied to carry the gases to the outside atmosphere in case of transformer failure, and after the diaphragm ruptures. This type of installation should be made where possible on transformers installed indoors. For outdoor transformers, the relief device is regularly provided with a vented outlet which allows gases to escape directly to the outside atmosphere. A screen under the diaphragm prevents broken pieces from falling into the transformer.

The relief diaphragm unit-assembly, which is bolted to the transformer cover or other suitable place, consists of a supporting flange in which the glass diaphragm is mounted between two cork gaskets. A tight joint between gasket and diaphragm on the supporting flange is made by a pressure ring against the lower gasket, all of which is clamped in place by stud bolts.

It is necessary to be very careful bolting down the pressure-ring to avoid breakage of the glass diaphragm for its rupture strength depends largely upon having an even distribution of clamping pressure applied to the diaphragm.

Make sure that gasket seats are thoroughly clean. Apply Cement S#471880 to both sides of the upper gasket and put the glass diaphragm in place, being sure that both the gasket and the diaphragm are centrally located in the supporting flange. Lay the cushion or lower gasket in place over the glass diaphragm and assemble the pressure ring over this gasket. Then tighten the assembly by means of the nuts and lock washers on the stud bolts.

An even distribution of pressure on the glass diaphragm can be obtained only by tightening the nuts uniformly. This should be done by tightening alternate nuts until the lock washers are nearly compressed. The other nuts should then be tightened in a similar manner. This alternate nut tightening should be continued until the face of the pressure-ring is against the metal gasket-stop. Thread a wire through the holes in the studs and fasten its ends securely.

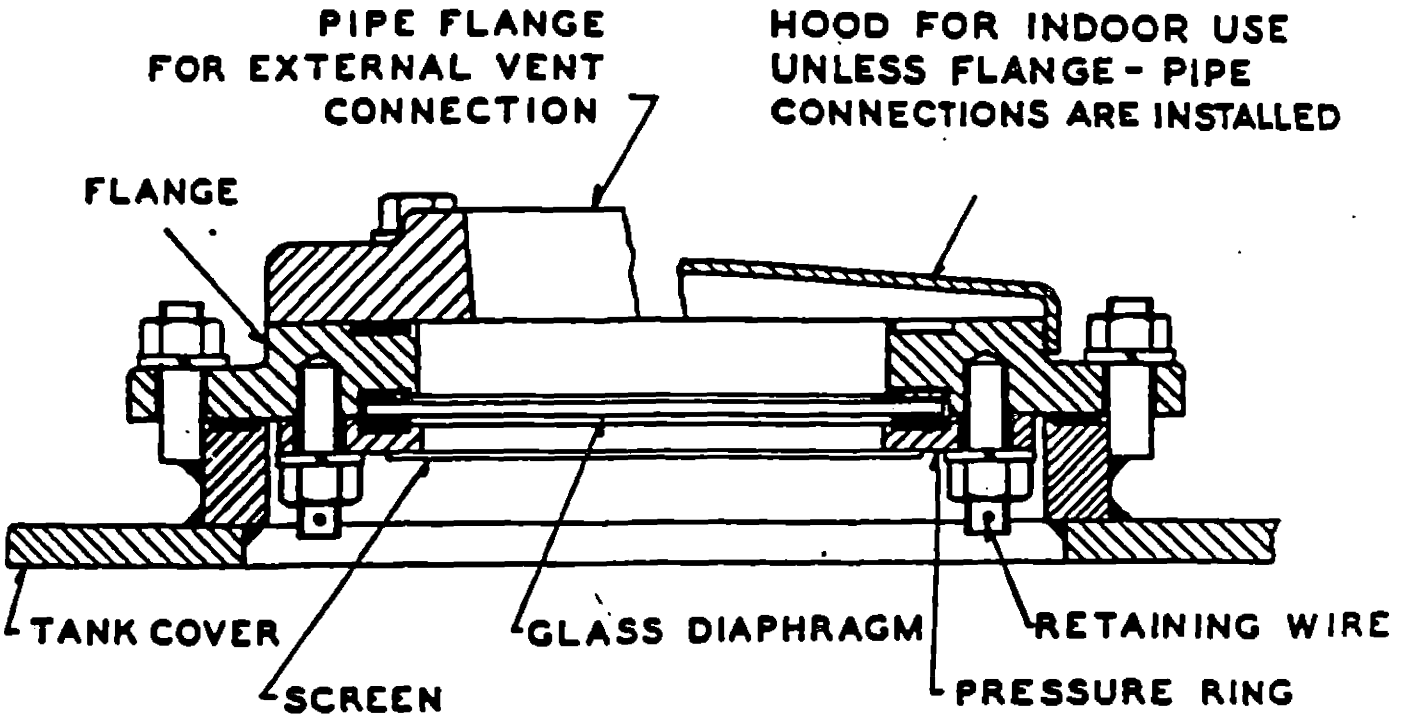


Fig. 1 - Westinghouse Pressure Relief Device
Sectional View

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Diaphragm relief devices are assembled on the transformer at the factory and they are then pressure-tested at 7 lbs. per square inch and shipped in place.

Two spare diaphragms and the necessary gaskets and cement are shipped with each transformer. Additional diaphragms, if needed, should be ordered from the Westinghouse Electric & Manufacturing Company, Sharon, Pennsylvania, identified by the serial number of the transformer.

Rotary Type Sampling Device - The rotary type sampling device supplied on Inerteen Transformers provides a convenient means of draining a sample of Inerteen for test purposes. Due to the high specific gravity of Inerteen, water tends to collect on the surface of the Inerteen. Therefore, in order to obtain a sample that will be representative of the surface Inerteen in the transformer, the sampling valve is located near the Inerteen level.

This device is designed to skim a sample from the surface, and may also be used in applying pressure tests.

Fig. #2 shows a sectional view of the rotary type valve. The tube should be left in a vertical position as shown. A sample is taken by turning the operating knob to the right. The travel is limited to 90 degs. by position-stops on the body of the device. A position indicator is made a part of the operating knob, attached to the shaft in the same plane as the tube. A packing gland prevents the leakage of Inerteen along the operating shaft.

When the knob is turned, the end of the tube passes under the Inerteen level, allowing the Inerteen to enter the tube and flow to the sampling-plug. The device may be equipped with a plug type Belknap sampling valve, Figs. 990-A or 992, a spring-closing Belknap valve, Figs. 995 or 994, or spring-closing Waterbury valve #108.

The sampling device is easily removed as a unit from the tank. A 1-1/4" hex is provided for this purpose.

If the device is equipped with a spring-closing valve, remove the dust cap from the valve. Remove the inner dust cap from the proper operating device and screw the operating device tightly onto the valve. This releases the ball-check in the valve. Rotate the operating knob slowly, using a wrench to fit the 1-1/8" hex on this knob; until the Inerteen begins to flow. At this point the rotation should be stopped to insure obtaining a true sample of the top liquid.

A screw driver or coin may be used to open and close the plug type valve, Belknap Fig. 990-A. The Belknap 992 valve is operated by turning the knurled knob.

When pressure tests are required, they should be made before withdrawing samples of Inerteen. To make a pressure test, the indicator arm should be in the vertical position. If a spring-closing valve is used, remove dust caps

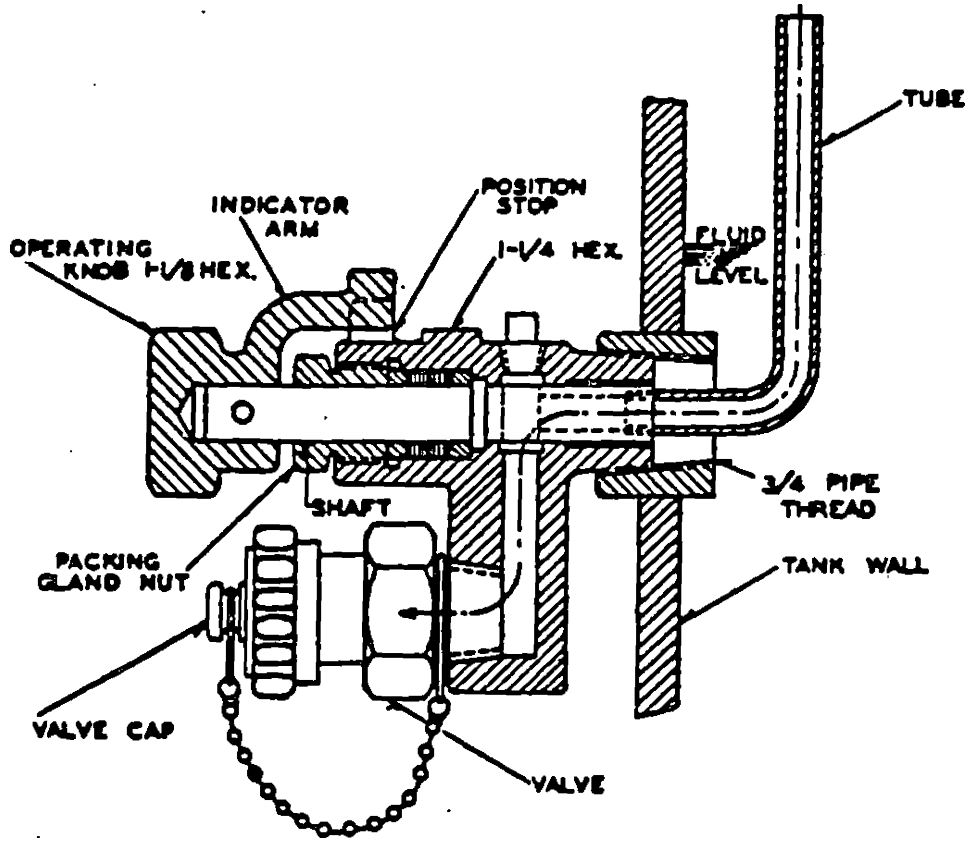

Fig. 2 - Westinghouse Rotary Type Sampling Valve Sectional View

from pressure-testing device and attach the device to the spring closing valve. To apply pressure, attach operating device to pressure-testing device. Any pressure in the transformer tank may be released by removing the operating-device and releasing the check valve in the pressure-testing device. If a plug type valve is used, connect the pressure gage to the valve by means of a metal tube or hose. Open valve, using a screw driver or coin, and note pressure on gage. If sample of gas is desired, connect hose to a suitable container.

If the Inerteen is above the 25°C. level, the pressure will be somewhat above atmospheric while if the Inerteen is below the 25°C. level there will be a partial vacuum in the tank. It is therefore advisable to take the sample when the gage shows the Inerteen to be at, or slightly above the 25°C. level. If the sample is taken at a higher or lower Inerteen level, provision should be made to relieve any pressure or vacuum which may be created. This may be done by restoring the pressure to the proper point by forcing air into or pumping air out of the tank. This should be done with the tube of the sampling device in a vertical position.

The rotary type sampling device is ruggedly constructed and requires very little servicing or maintenance. If there is a slight leakage through the packing gland the gland nut should be tightened. In case this does not stop the leakage the gland should be repacked. Packing Style #1066507 may be obtained from Westinghouse Electric & Manufacturing Company, Sharon, Penna. In ordering, include the transformer serial number.

Gas Absorbers for Inerteen Transformers - When Inerteen transformers are equipped with gas absorbers, separate instructions are shipped with each transformer describing the device and its installation, operation and maintenance.

Renewal Parts

When information is required concerning a transformer, always give its serial number, particularly whenever renewal or stock parts are ordered. The serial number will be found engraved on the nameplate attached to the transformer tank and on the small nameplate attached to the top or end of the core and coils assembly. Whenever possible, a sketch showing the part or parts and their exact locations, will materially help to assure that the proper parts are supplied by the Factory. This sketch should always indicate the direction or side of the transformer from which the view is made.

NOTE: Some transformers are ordered designed for Inerteen but are to be operated first as oil-insulated transformers. Consequently, they are shipped from the factory filled with oil. Whenever it is desired to operate these transformers with Inerteen, complete instructions for the removal of the oil, the cleaning of the transformer and filling it with Inerteen should be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Pennsylvania.

Revised: January, 1942

INERTEEN

Inerteen is a synthetic non-inflammable and non-explosive insulating and cooling liquid used in Westinghouse Inerteen Transformers.

Characteristics

Color	Straw Yellow
Viscosity at 100°F. (Saybolt).	54 Seconds
Fire Point	None
Specific Gravity at 60°F.	1.564
Dielectric Constant	4.5

Mineral oil is completely miscible with transformer Inerteen. It is practically impossible to separate mineral oil and Inerteen; therefore, it is important to avoid contamination of Inerteen with any oil as the presence of such materials changes the non-inflammable and non-explosive characteristics of Inerteen.

Inerteen is chemically stable. It is not affected by reaction with other materials used in the manufacture of Inerteen Transformers. It is non-oxidizing and non-corrosive at temperatures considerably above those normally obtained in transformers. Inerteen will not form sludge under any conditions.

Inerteen exerts a strong solvent action on most of the ordinary varnishes, gums and paints commonly used in oil-insulated transformers. Such materials, therefore, are not used in the design and construction of Inerteen Transformers. It is necessary to use such material as pure cellulose, cotton, paper and porcelain. This requirement, coupled with the necessary use of tight-tank construction for Inerteen Transformers tends to give improved operating characteristics.

If Inerteen is decomposed by an electric arc, hydrogen chloride gas is evolved. The products of arc decomposition are harmful to the transformer structure. Where severe arcing occurs, the solid insulation of the transformer becomes saturated with hydrogen chloride and the affected parts must be removed in the repair of the transformer.

The dielectric strength of Inerteen compares favorably with and under average normal conditions will be found higher than that of transformer oil. The same precautions are necessary with Inerteen as are taken with transformer oil. Inerteen should be kept free of moisture, lint and dirt.

Inerteen has an irritating effect upon the skin. This is more pronounced to some persons than to others. Especially the eyes, nose and lips are affected when coming in contact with Inerteen and certain safety precautions must be observed when handling it. When working with the hands in Inerteen, it will irritate skin abrasions or the tender parts between the fingers. Continued exposure may cause skin eruptions with certain individuals due to absorption of the Inerteen through the pores of the skin. Cleanliness among workmen handling Inerteen is essential and a very good safeguard against such effects. An application of castor oil is recommended for the eyes and castor oil or cold cream for the nose and lips. In case Inerteen comes in contact with the skin, the parts should be thoroughly washed and cleaned. A supply of these materials should be kept available at all times where men are working with Inerteen.

Hot transformers should not be opened except in well ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, it should be changed as soon as possible and the soiled clothing laundered before it is worn again. Gloves, S#1184650, which are resistant to Inerteen, should be worn where it is necessary to put one's hand in Inerteen or where parts of transformers are handled wet.

INERTEEN TRANSFORMERS

Shipment

Inerteen Transformers are always constructed in pressure-tight tanks.

Inerteen transformers are shipped properly filled with Inerteen and ready for installation. This prevents the entrance of moisture into the windings during transit and usually makes it unnecessary to dry the transformers prior to installation. A small amount of moisture will reduce the dielectric strength of Inerteen. It may be present in vapor form in the gas space above the Inerteen level or from minute leaks.

Transformers equipped with switch or terminal chambers which must be opened for installation, are shipped with the Inerteen for these chambers in separate containers.

Activated clay has a high affinity for moisture and absorbs other materials which may contaminate Inerteen. To keep the Inerteen in the best condition, bonded tubes of activated clay are installed and shipped in place in switch and terminal chambers of new transformers. When the Inerteen is shipped in separate containers the tubes are also shipped separately, enclosed in air-tight containers.

Inerteen must always be kept in sealed containers to prevent the loss of its more volatile constituents by evaporation or possible contamination from dirt or moisture.

Moving Transformers

Lugs are provided for lifting the complete transformer, and when necessary, additional means are provided for lifting the different parts. The transformer should be lifted by the means provided and when necessary, spreaders should be used to obtain a balanced lift. Transformers should not be moved or lifted by placing jacks or other devices against or under cooling tubes, radiators, valves or other fittings. Skids should be used to distribute the stresses properly over the base when transformers are moved on rollers.

Carefully inspect the transformers for damage during shipment.

This should include a check of the In- level and the tightening of any parts ave become loose or out of place and there is any evidence of moisture having the transformer. Inerteen used for fill- sformers should have a dielectric strength V or higher. When the dielectric strength teen in transformers in service reaches r lower, it should be filtered. If the ric strength is very low or if there is e of free water, the core and coils should d.

Where transformers are to be used at ltitude (more than 3000 ft. above sea level) ing above the liquid level should be open- equalize the internal and external pres- at a temperature of approximately 25°C. be- lacing the transformer in service. Be sure the fitting is closed after equalizing the ure.

All transformers are carefully tested e Factory and in good condition when ship- is made but it is desirable to inspect each former thoroughly before placing it in ser-

nding and Making Connections

No matter what the type of floor or dation on which the transformer is to rest, tank should be definitely and permanently nded by connecting a lead to the grounding nection provided for that purpose near the tom of the tank.

Terminal board, tap changer and other nections should never be changed with voltage the transformer. Do not make any connections ept those indicated on the diagram or the dia- m nameplate shipped with the transformer.

Any lead or connector not in use should insulated from all other leads and connectors l from ground.

skets

Gaskets used on Inerteen Transformers e made from a high grade of cork and, it is commended, in replacing any gaskets that they e made of cork. Before replacing a gasket, all sket surfaces should be thoroughly cleaned free rust, oil, grease, paint or other foreign ma- erials. The cleaning may be done by scraping or ire-brushing and then wiping the gasket surface ith denatured alcohol.

Gasket Cement S#471880 especially de- veloped for use with Inerteen, should always be sed in applying gaskets. Thoroughly brush the cement on the tank surface and on the bottom side of the gasket. Place the gasket in position and apply weights or other means to obtain good ad- hesion of the gasket to the metal surface. The gasket should be allowed to set approximately one-half hour before the weights are removed. Cement should then be applied to the top surface of the gasket. The gasket surfaces must immedi- ately be bolted together under a uniform pressure.

Transformers are frequently equipped with terminal or switch compartments into which cables enter by means of potheads. In some cases, it will be necessary to remove the switch-cover to make the cable connections.

When transformers are designed for bayo- net connections, it is only necessary to remove the bayonet pothead, make the cable connections and replace the pothead.

Extra gaskets and Cement S#471880 are furnished with all Inerteen Transformers where their installation requires the removal of any gaskets. Additional gaskets and cement should be ordered from the manufacturer.

Pipe Fittings

Care should be taken to see that threads of pipe fittings are not damaged. All threads should be thoroughly cleaned to remove dirt, grease, etc. After cleaning, apply Cement S# 471880 to the threads of each fitting. Immedi- ately screw the proper fittings together tightly.

Pressure Testing

All Inerteen transformers are pressure tested at the factory and shipped free of leaks. After installation 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 the installation. Dry compressed nitrogen or air should be used at a test pressure of 7 lbs. per square inch for a period of six hours. It is suggested that the air space above the Inerteen be blown out with nitrogen, all vents closed and the pressure test applied. The test pressure can best be limited by the use of a regulating valve on the nitrogen cylinder. A check for leaks above the Inerteen level may be made with a solution of soap and water applied to all gasketed-joints, screwed- fittings and wiping-sleeve connections.

Paint

Inerteen Transformers are finished with a special paint, which is resistant to the sol- vent action of Inerteen. A sufficient quantity of this paint S#302509 is furnished with each transformer to "touch up" any places damaged during the process of installation.

Storage

Inerteen Transformers must always be stored filled to the proper level with Inerteen, otherwise a certain amount of moisture may accu- mulate on account of variations of air tempera- ture. Inerteen Transformers should be stored in a dry place, and where minimum temperature changes will occur.

Where it is necessary to temporarily store coils, insulation or other parts for the complete core and coil assembly of an Inerteen Transformer, they should be immersed in Inerteen to prevent moisture absorption. If such storage is necessary for a long period of time, the tank or storage container must be sealed to prevent the entrance of moisture and the evaporation of Inerteen.

Inerteen Transformers which have been idle or stored for an appreciable length of time, should be put into service only after making cer-

tain that the transformer is dry and that the dielectric strength of the Inerteen tests 22,000 volts or higher. The inspection instructions should also be followed.

Maintenance

Inerteen Equipment - Care must be exercised in handling Inerteen to prevent contamination since impurities alter its non-inflammable and electrical characteristics. It must be handled in thoroughly clean containers free from oil. If there is any question concerning the cleanliness of the containers, they should be thoroughly washed with Trichlorbenzene M-6872 and dried before any Inerteen is placed in them. The transformer tank or any of its compartments in which Inerteen is used, must be free from oil and other contaminating materials.

Inerteen should not be mixed with vegetable oils since these materials affect the deterioration, D.C. resistance and otherwise contaminate it. Compounds of asphaltic nature, paraffin and ordinary soldering flux are particularly harmful to Inerteen.

For soldering, a solution of rosin in alcohol is recommended.

All-metal hose must be used in handling Inerteen since the lining used in most hose is soluble in Inerteen.

Filling Transformers - When it is necessary to fill a transformer with Inerteen one should make sure that all joints are tight; Cement S#471880 should be used for this purpose. Steel pipe or metal hose should be used, and preferably the transformer should be filled through the drain valve. This will keep aeration of the Inerteen to a minimum. See that air vents are open as the transformer is filled.

It is desirable to fill a transformer by passing the Inerteen through an Inerteen Conditioner. If this cannot be done and the Inerteen tests satisfactorily, fill the transformer by passing the Inerteen through three thicknesses of tightly woven white cloth, which has first been washed in Trichlorbenzene and dried to remove any sizing. New cloths should be used for at least every two transformers.

When it is necessary to fill Inerteen transformers out-of-doors and particularly on damp days due precaution must be taken to prevent the entrance of moisture into the transformer.

Filling Switch and Terminal Chambers - Care should be exercised when filling switch and terminal chambers with Inerteen, and during servicing to avoid contamination by moisture or dirt, which may lower the dielectric strength of the Inerteen. The moisture may be present during the filling operation due to condensation and absorption on the inside of the chamber walls, or may appear as vapor in the gas space above the Inerteen or from any minute leaks.

The use of bonded tubes of activated clay in Inerteen-filled chambers of transformers in service is recommended where routine tests show the Inerteen to have unsatisfactory dielectric strength.

The tubes should not be removed from their containers until the terminal chamber is ready for their installation. The tubes should not be exposed to air more than approximately thirty minutes before closing up the chamber preparatory to filling it with Inerteen unless they are first dried for two hours at a temperature of approximately 250°C. or for twelve hours at 135 to 150°C.

If it becomes necessary to drain the Inerteen or to open the chamber after a period of service, it is recommended that new tubes be installed. To do this, it is only necessary to remove the bolts holding the spring clips, remove the old and insert the new tubes, and replace the clips and bolts.

When an Inerteen Conditioner is not available for use in filling chambers with Inerteen, it is recommended that the Inerteen be strained through two or three layers of tightly woven white cloth and poured through a container in which three or four clay tubes have been broken into small pieces. This will materially reduce the possibility of contamination of the Inerteen from dirt and moisture.

Bonded clay tubes should be ordered as Style #1150140 from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. It is also desirable when ordering new tubes to identify the transformer for which they are required by including the serial number of the transformer.

Periodic Inspections

Inerteen - It is desirable that top and bottom samples of Inerteen be taken from each transformer and tested after a short period of operation. When operating conditions permit, routine sampling of the Inerteen at intervals of six months is recommended. Accurate records should be kept of such inspections and tests, and if the Inerteen shows a dielectric strength of less than 22 KV the Inerteen should be conditioned. This depends somewhat on the transformer load cycle and climatic conditions. If no facilities are available for making dielectric tests on Inerteen, samples should be sent to the Westinghouse Electric & Manufacturing Company, Sharon, Penna. Each sample of Inerteen should be properly identified by the transformer serial number and it should be marked whether taken from the top or bottom of the tank or from a tank-compartment. Samples should be carefully packed to avoid breakage in transit. Whenever any appreciable amount of Inerteen is removed from a transformer, it should be replaced with an equal amount of new Inerteen of proper dielectric strength so that the liquid level in the transformer is maintained.

Operation of Transformers - It is recommended that a periodic check be made of the operating temperatures of Inerteen transformers and that the temperature of the Inerteen be kept below 90°C. for a maximum-rated self-cooled transformer.

Paint - The external tank surfaces of Inerteen Transformers should be examined particularly for signs of corrosion. If appreciable corrosion is found, its cause should be determined and, if possible, removed. Transformer tanks are usually painted with

ting, copper-bearing steel, and they are finished with a high grade Inerteen-resisting paint which is baked on at high temperature. Any surface which is found corroded should be thoroughly cleaned to the bare metal and refinished with one coat of primer, and two coats of finish paint S#302509. Allow twelve hours drying time between each coat of paint.

Taking Samples of Inerteen

All sampling and testing equipment must be thoroughly dry and clean. It is recommended that sampling and testing equipment used for Inerteen Transformers be used for no other purpose. Care must be used in obtaining and sealing samples of Inerteen taken from a transformer.

Use only small tin containers with screwed metal-gasket caps or small glass bottles with glass stoppers for holding Inerteen samples.

If it becomes necessary to use other than Factory sampling containers, such containers should be thoroughly rinsed with clean gasoline, washed with strong soap suds and rinsed thoroughly in hot water, and then dried in an oven at approximately 110°C. for one hour. If the containers are not used immediately after cleaning, they should be sealed tightly and stored in a dry, clean place.

Inerteen sampling package S# 1065658 may be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Penna. This package consists of four 1-pint cans of Inerteen, packed and shipped in cardboard cartons. This Inerteen may be used to replace that removed from a transformer as a sample. If samples are not taken immediately after emptying the containers, the empty containers should be tightly capped to prevent admittance of moisture.

It is desirable that samples of Inerteen be removed from a transformer tank or from a drum on clear days only and when the Inerteen is at least as warm as the surrounding air.

The sample of Inerteen should be removed near the surface of the fluid. This can be done readily through the rotary sampling device and valve. It is also recommended that a sample be taken from the bottom of the tank, particularly from the bottom of switch or terminal-chambers. If the sample is withdrawn through a valve connection, this connection should be flushed by allowing a small amount of Inerteen to run out before collecting the sample. The sample should be immediately placed in the container and the cap screwed on tightly. The sticker on each container should be marked to identify the sample of Inerteen with the transformer from which it was taken and whether taken from the top or bottom.

Before taking samples from a drum, the Inerteen should be allowed to settle for approximately twelve hours. Samples from the top of the drum should be removed by means of a clean glass sneak-thief.

The same precautions to prevent moisture contamination should be used in sampling Inerteen as are observed in taking transformer oil samples. Sampling equipment should be used only for Inerteen.

Dielectric Testing of Inerteen

The same rules and precautions as normally followed in testing oil should be used in testing Inerteen, except as herein stated.

The test cup should be wiped with a clean, dry chamois and thoroughly rinsed with clean gasoline and allowed to dry before being used. The electrode spacing should be checked.

To determine whether the test cup is suitable for testing Inerteen, fill it with dry gasoline and test this under a standard voltage rise of 3 KV per second. If the dielectric strength of the gasoline is not less than 32 KV, the test cup is suitable for testing Inerteen, after the cup has been dried in an oven where the temperature does not exceed 50°C. to remove all traces of gasoline. Care should be exercised in handling gasoline as it is highly inflammable. In testing Inerteen, make only one "shot" per filling of the test cup. Five different fillings should be made and the average result used.

Drying and Filtering Inerteen

Inerteen may be dehydrated and filtered by means of an oil filter press but in order that it may not be contaminated, it is necessary that the filter press be used for Inerteen only.

A different procedure than that followed for oil is required to purify Inerteen. Contamination in Inerteen cannot be removed entirely by filter paper alone. To clean Inerteen thoroughly it must be filtered through "activated clay" which absorbs impurities. In practice, it is only necessary to pass the Inerteen through the clay and to separate the clay mechanically from the Inerteen to obtain clean Inerteen of proper dielectric strength.

The Inerteen Conditioner

The equipment recommended for conditioning Inerteen consists of an activated clay chamber and filter press with suitable inlet and outlet connections and other necessary fittings.

The activated clay is contained in a tank mounted on one end of the filter press. The Inerteen is pumped up through the clay insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through a wire screen prior to entering the filter press to remove practically all of the clay.

The cover of the tank incorporates an air-trap and vent to avoid pumping air into the transformer which might result from a leak in the suction line. A strainer is provided on the suction side of the pump, so constructed that all dirt collected is removed with the screen. A by-pass connection fitted with a needle valve is used for testing the suction line from the transformer for leaks.

The filter press consists of 15 frames and 16 plates alternately spaced mounted in a yoke. One sheet of blotting paper is used between each plate and frame to provide a gasket-seal and to remove all traces of clay from the Inerteen.

A pressure gage indicates the operation and two by-pass valves assure safe operation of the Conditioner by preventing excessive pressures and serve as a check to overloading and stalling the motor. One valve, connected across the pump, is set to by-pass the Inerteen at a pressure of 60 to 70 lbs. per square inch. The other valve is provided on the discharge side of the Conditioner connecting to the transformer. This by-pass valve, releasing at a pressure of approximately 5 lbs. per square inch, will avoid breaking the transformer relief diaphragm when no other relief is provided.

To Prepare the Conditioner for Operation

Remove the cover and screen from the clay tank and fill the tank with activated clay, H-6934, to within four inches of the bottom edge on the inner flange. Replace screen and cover. Release the pressure-screw of the filter press and loosen plates and frames. Place one sheet of "B" size blotting paper between the face of each frame and plate. Care should be used to see that the holes through the plates, frames and paper are in proper alignment before the pressure-screw is tightened. Close the discharge, tank by-pass, tank drain, suction and suction-test valves. Pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons of Inerteen. Start the motor and open the drip pan valve so that not less than 5 minutes are required to fill the clay tank, saturating the clay with Inerteen. With the valve at the transformer closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is therefore considered advisable to condition Inerteen from the top and return it to the bottom of the tank. To begin conditioning Inerteen in a transformer, close the suction test valve and stop the motor. Open the transformer valves. Open the Conditioner discharge and suction valves. Close the drip pan valve and start the motor.

One charge of clay will condition approximately 3000 gallons of Inerteen, depending upon the amount of contamination present.

When it is necessary to change the clay, first close the valve in the suction line, close the tank inlet and outlet valves, open the tank by-pass valve and tank drain valve to permit the free Inerteen in the tank to drain into the lower drip pan. Open the drip pan valve and pump the Inerteen from the drip pan through the filter press. Additional Inerteen may be forced out of the clay by applying air pressure to the air vent. Shut down the motor and remove the clay from the tank and refill with fresh clay as previously described.

To change the filter or blotting papers, stop the motor, close the tank by-pass valve, the tank inlet valve and the tank drain valve, if these valves are open. Open the tank outlet valve and apply air pressure to the air vent until the free Inerteen has been driven out of the blotting papers. Then release the pressure-screw and remove the papers.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to again resume conditioning the Inerteen.

To Dry Inerteen Transformers

Inerteen Transformers should be dried by the short-circuit method with the transformer in its tank immersed in the Inerteen. During the heating and drying process, the top of the tank should be vented to the air to prevent moisture condensation. The desired load current should be obtained by short-circuiting one winding and impressing the proper voltage on the other winding. If the full load impedance of the transformer is not known or not engraved on the transformer nameplate, it should be obtained from the Westinghouse Electric & Manufacturing Company by identifying the transformer with its serial number.

Transformer windings in Inerteen should first be heated under a partial load. A higher top Inerteen temperature can be obtained more quickly by blanketing the tank with the cover removed to prevent condensation.

If the transformer is at or lower than room temperature at the start of the drying process, from 125% to 150% full load current will hasten the heating. The temperature should be carefully watched and when the Inerteen reaches a temperature of 60°C., the load should be reduced to obtain an approximately constant Inerteen temperature based on the following table. These temperatures should not be exceeded for a given load.

Short Circuit Amperes in Percent of Load	Max. Temperature of Top Inerteen
50	85
75	75
85	70

The transformer may be dried more quickly if it is possible to filter the Inerteen during the drying process. If the filtering is continuous, care should be taken to keep the Inerteen temperature above 60°C. If moisture condenses on the underside of the cover, the rate of temperature rise should be decreased until condensation ceases. To prevent condensation the tank temperature may be raised by blanketing the tank.

The drying should be continued until dielectric tests of samples of the Inerteen taken from the top and bottom of the tank show 30 KV or higher. The tests should be made in a standard test cup and it is recommended that at least two consecutive tests of both the top and bottom Inerteen be made at least 24 hours apart while the Inerteen is near a maximum temperature. Tests of the Inerteen should not be made during the filtering process.

If Transformers Fail in Service

Should an Inerteen Transformer fail in service, the nearest Westinghouse Electric & Manufacturing Company District Office should be notified as soon as possible. Give the rating of the transformer and its serial number and, if possible, the conditions under which the failure took place. Samples of the Inerteen should be taken so that an analysis of it can be made. The transformer should be kept immersed in Inerteen and it is recommended that no work be done on the transformer except under advice from the District Office.

Accessories for Inerteen Transformers

Pressure Relief Diaphragms - All transformers above 25 KVA are furnished with a pressure relief diaphragm. Fig. #1 shows a sectional view. This device is made in different sizes to provide ample venting for different ratings.

Relief diaphragms are regularly supplied, arranged so that a flange with the necessary piping may be applied to carry the gases to the outside atmosphere in case of transformer failure, and after the diaphragm ruptures. This type of installation should be made where possible on transformers installed indoors. For outdoor transformers, the relief device is regularly provided with a vented outlet which allows gases to escape directly to the outside atmosphere. A screen under the diaphragm prevents broken pieces from falling into the transformer.

The relief diaphragm unit-assembly, which is bolted to the transformer cover or other suitable place, consists of a supporting flange in which the glass diaphragm is mounted between two cork gaskets. A tight joint between gasket and diaphragm on the supporting flange is made by a pressure ring against the lower gasket, all of which is clamped in place by stud bolts.

It is necessary to be very careful bolting down the pressure-ring to avoid breakage of the glass diaphragm for its rupture strength depends largely upon having an even distribution of clamping pressure applied to the diaphragm.

Make sure that gasket seats are thoroughly clean. Apply Cement S#471880 to both sides of the upper gasket and put the glass diaphragm in place, being sure that both the gasket and the diaphragm are centrally located in the supporting flange. Lay the cushion or lower gasket in place over the glass diaphragm and assemble the pressure ring over this gasket. Then tighten the assembly by means of the nuts and lock washers on the stud bolts.

An even distribution of pressure on the glass diaphragm can be obtained only by tightening the nuts uniformly. This should be done by tightening alternate nuts until the lock washers are nearly compressed. The other nuts should then be tightened in a similar manner. This alternate nut tightening should be continued until the face of the pressure-ring is against the metal gasket-stop. Thread a wire through the holes in the studs and fasten its ends securely.

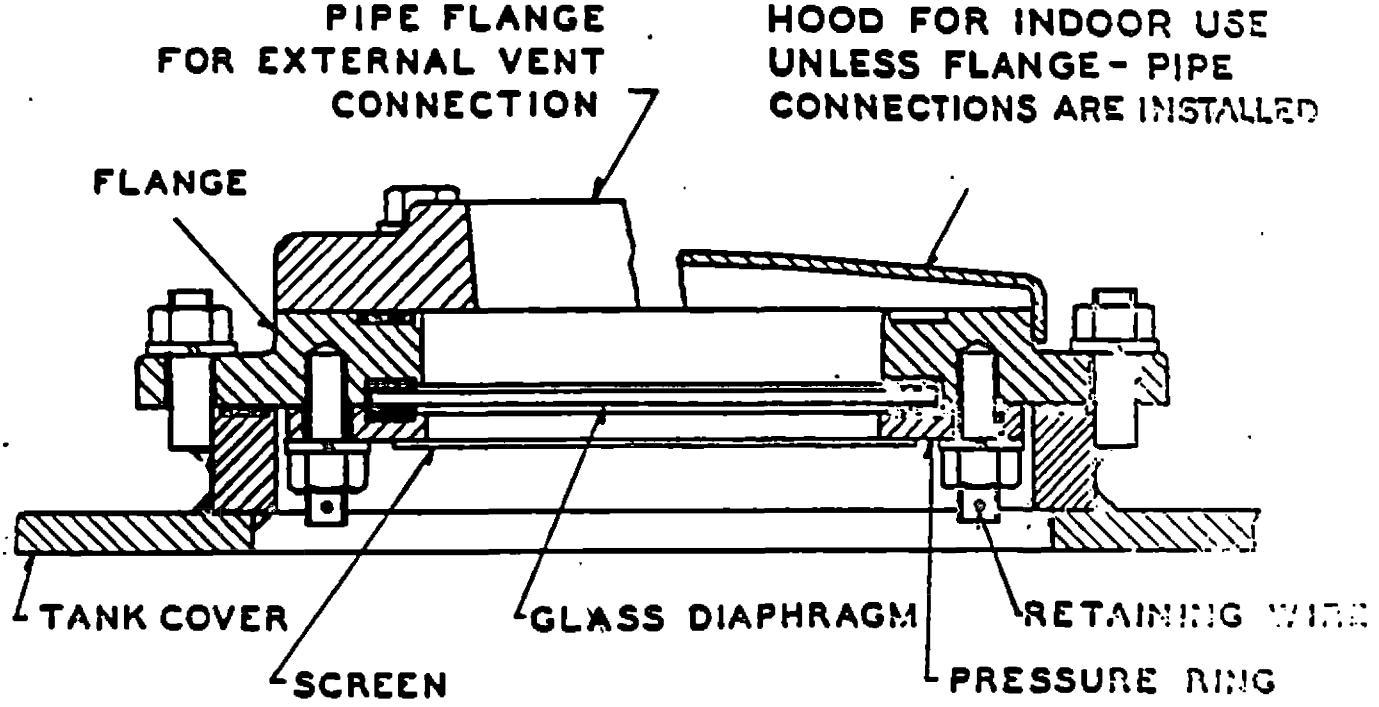

Fig. 1 - Westinghouse Pressure Relief Device Sectional View

Diaphragm relief devices are assembled on the transformer at the factory and they are then pressure-tested at 7 lbs. per square inch and shipped in place.

Two spare diaphragms and the necessary gaskets and cement are shipped with each transformer. Additional diaphragms, if needed, should be ordered from the Westinghouse Electric & Manufacturing Company, Sharon, Pennsylvania, identified by the serial number of the transformer.

Rotary Type Sampling Device - The rotary type sampling device supplied on Inerteen Transformers provides a convenient means of draining a sample of Inerteen for test purposes. Due to the high specific gravity of Inerteen, water tends to collect on the surface of the Inerteen. Therefore, in order to obtain a sample that will be representative of the surface Inerteen in the transformer, the sampling valve is located near the Inerteen level.

This device is designed to skim a sample from the surface, and may also be used in applying pressure tests.

Fig. #2 shows a sectional view of the rotary type valve. The tube should be left in a vertical position as shown. A sample is taken by turning the operating knob to the right. The travel is limited to 90 degs. by position-stops on the body of the device. A position indicator is made a part of the operating knob, attached to the shaft in the same plane as the tube. A packing gland prevents the leakage of Inerteen along the operating shaft.

When the knob is turned, the end of the tube passes under the Inerteen level, allowing the Inerteen to enter the tube and flow to the sampling-plug. The device may be equipped with a plug type Belknap sampling valve, Figs. 990-A or 992, a spring-closing Belknap valve, Figs. 993 or 994, or spring-closing Waterbury valve #108.

The sampling device is easily removed as a unit from the tank. A 1-1/4" hex is provided for this purpose.

If the device is equipped with a spring-closing valve, remove the dust cap from the valve. Remove the inner dust cap from the proper operating device and screw the operating device tightly onto the valve. This releases the ball-check in the valve. Rotate the operating knob slowly, using a wrench to fit the 1-1/8" hex on this knob, until the Inerteen begins to flow. At this point the rotation should be stopped to insure obtaining a true sample of the top liquid.

A screw driver or coin may be used to open and close the plug type valve, Belknap Fig. 990-A. The Belknap 992 valve is operated by turning the knurled knob.

When pressure tests are required, they should be made before withdrawing samples of Inerteen. To make a pressure test, the indicator arm should be in the vertical position. If a spring-closing valve is used, remove dust caps

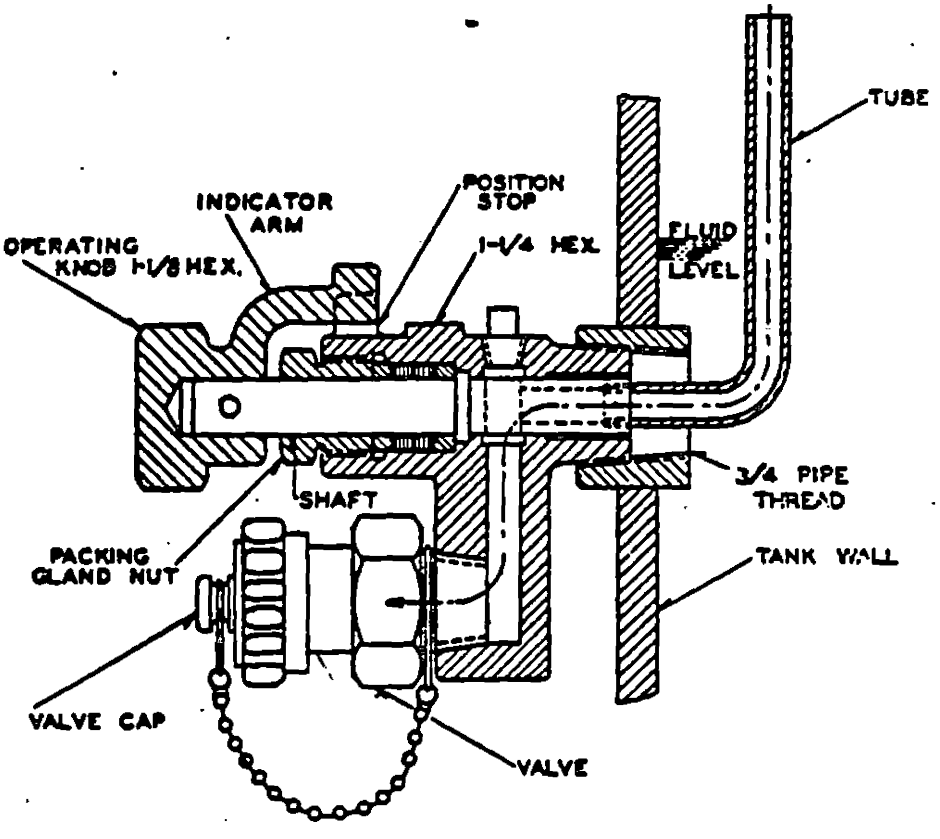

Fig. 2 - Westinghouse Rotary Type Sampling Valve
Sectional View

from pressure-testing device and attach the device to the spring closing valve. To apply pressure, attach operating device to pressure-testing device. Any pressure in the transformer tank may be released by removing the operating-device and releasing the check valve in the pressure-testing device. If a plug type valve is used, connect the pressure gage to the valve by means of a metal tube or hose. Open valve, using a screw driver or coin, and note pressure on gage. If sample of gas is desired, connect hose to a suitable container.

If the Inerteen is above the 25°C. level, the pressure will be somewhat above atmospheric while if the Inerteen is below the 25°C. level there will be a partial vacuum in the tank. It is therefore advisable to take the sample when the gage shows the Inerteen to be at, or slightly above the 25°C. level. If the sample is taken at a higher or lower Inerteen level, provision should be made to relieve any pressure or vacuum which may be created. This may be done by restoring the pressure to the proper point by forcing air into or pumping air out of the tank. This should be done with the tube of the sampling device in a vertical position.

The rotary type sampling device is ruggedly constructed and requires very little servicing or maintenance. If there is a slight leakage through the packing gland the gland nut should be tightened. In case this does not stop the leakage the gland should be repacked. Packing Style #1066507 may be obtained from Westinghouse Electric & Manufacturing Company, Sharon, Penna. In ordering, include the transformer serial number.

Gas Absorbers for Inerteen Transformers - When Inerteen transformers are equipped with gas absorbers, separate instructions are shipped with each transformer describing the device and its installation, operation and maintenance.

Renewal Parts

When information is required concerning a transformer, always give its serial number, particularly whenever renewal or stock parts are ordered. The serial number will be found engraved on the nameplate attached to the transformer tank and on the small nameplate attached to the top or end of the core and coils assembly. Whenever possible, a sketch showing the part or parts and their exact locations will materially help to assure that the proper parts are supplied by the Factory. This sketch should always indicate the direction or side of the transformer from which the view is made.

NOTE: Some transformers are ordered designed for Inerteen but are to be operated first as oil-insulated transformers. Consequently, they are shipped from the factory filled with oil. Whenever it is desired to operate these transformers with Inerteen, complete instructions for the removal of the oil, the cleaning of the transformer and filling it with Inerteen should be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Pennsylvania.

NOTE: "Inerteen 7336-8 is regularly used in all new Westinghouse Inerteen transformers. Inerteen 7336-8 supersedes Inerteen 7336-7. Inerteen 7336-8 has improved characteristics so that if arcing occurs in an Inerteen transformer, the insulating materials are not so quickly or so greatly impaired as a result of the formation of hydrogen chloride. This improved characteristic of 7336-8 Inerteen may be obtained from 7336-7 Inerteen by adding a certain concentrate to 7336-7 Inerteen. If it is desired to make this conversion, complete instructions for doing it should be obtained from the Westinghouse Electric & Manufacturing Company, Sharon, Pennsylvania."

Revised: November, 1946

INSTRUCTION BOOK

INERTEEN
INSULATING FLUID

for

Electrical Apparatus

CC200316

Westinghouse Electric Corporation

I.B. 44-860.1

Westinghouse Exhibit 5

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SPECIAL INQUIRIES

When communicating with Westinghouse regarding the product covered by this Instruction Book, include all data contained on the nameplate attached to the equipment.* Also, to facilitate replies when particular information is desired, be sure to state fully and clearly the problem and attendant conditions.

Address all communications to the nearest Westinghouse representative as listed in the back of this book.

*For a permanent record, it is suggested that all nameplate data be duplicated and retained in a convenient location.

RECEIVING • TESTING • RECONDITIONING

INSTRUCTIONS

INERTEEN®

INSULATING FLUID

P.D.S. 7336-9

for

Electrical Apparatus

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.

NEW INFORMATION
Printed in U.S.A.

FEBRUARY, 1952
C0230329 (Rep. 7-54)

INERTEEN* INSULATING FLUID

P.D.S. 7336-9

Inerteen is a synthetic non-inflammable and non-explosive insulating and cooling liquid. It has proved its suitability for use in all Westinghouse Inerteen insulated apparatus. In order to insure the proper performance of the apparatus, only Westinghouse Inerteen should be used.

This publication gives the instructions for handling, inspection, and maintenance which experience has shown are important in obtaining the best service from the Inerteen.

* Registered trade-mark for Westinghouse Askarel

RECEIVING, HANDLING, STORING

SHIPMENT

Inerteen is shipped in tank cars, drums, or cans. The modern tank cars are usually lagged to prevent rapid fluctuations in temperature during transit and thus reduce the amount of expansion and contraction of Inerteen. Changes in the volume of the Inerteen due to temperature changes tend to cause breathing in of moist air resulting in condensation of moisture inside the container, and lowering of the dielectric strength of the Inerteen.

When shipped in drums, the Inerteen and the drums are both heated above room temperature while the drums are being filled, and the bungs are tightened immediately after filling. After cooling to normal temperature, the bungs are again tightened. The drums are provided with screw bungs having gaskets to prevent admission of water.

When shipped in cans, the cans as well as the Inerteen are heated above room temperature while being filled and are hermetically sealed immediately after filling.

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. If loosened, be sure Inerteen is tested before using, or combining it with good Inerteen.

It is very desirable that Inerteen in drums be stored in a closed room. 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, protection against direct contact of rain and snow should be provided. Drums stored outdoors should be placed so that bungs will be protected from moisture. It is desirable to cover the drums with a tarpaulin.

Cans. Cans containing Inerteen must not be exposed to the weather. Seals should be kept intact until the Inerteen is actually needed.

Screw caps are provided on the cans to use when the Inerteen is only partially removed after hermetic seal has been broken. By replacing the screw caps, contamination by moisture and dirt will be retarded, but the Inerteen must be tested just before using.

Storage Tank. The storage tank should be mounted on piers so that it will not touch the ground, and will be accessible to all points for inspection for leakage.

It is desirable to maintain the temperature of the Inerteen and tank a little above the temperature of the surrounding air as this prevents condensation of moisture in the tank which would affect the dielectric strength of the Inerteen.

The tank should preferably have a convex bottom, allowing for the installation of a drain cock at the lowest point for removing dirt or tank scale which might settle out. As Inerteen is heavier than water, most all of any water present will, in time, rise to the top of the Inerteen. A valve somewhere near the normal top level of the Inerteen should be provided for drawing off water-contaminated Inerteen. Provision for drawing off the Inerteen should also be made near the bottom of the tank.

HANDLING

Caution: Inerteen is a skin irritant. Unnecessary contact with this liquid or its vapor, particularly when it is hot, should be avoided. Especially the eyes, nose, and lips are affected when Inerteen comes in contact with them. Certain safety precautions must be observed when handling Inerteen.

In case Inerteen comes in contact with the skin, the parts affected should be thoroughly washed in soapy water and followed by an application of cold cream. A supply of these materials should be kept available at all times where personnel are working with Inerteen. Continued exposure may cause eruptions on certain individuals due to the absorption of Inerteen through the pores

of the skin. Cleanliness among workmen handling Inerteen is a very good safeguard against such effects. Application of castor oil is recommended for the eyes, castor oil or cold cream for the nose and lips.

Hot apparatus should not be opened except in well-ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, the clothing should be changed as soon as possible and the soiled clothing laundered before it is worn again. Gloves such as Westinghouse S# 1389 974 should be worn when it is necessary to put one's hand into Inerteen or when parts of apparatus must be handled wet.

Mineral oil is completely miscible with Inerteen and it is practically impossible to separate them. Therefore, it is important to avoid contaminating Inerteen with any kind of oil, since its presence changes the non-inflammable and non-explosive characteristics of Inerteen.

Note: The Inerteen should be sampled and tested before being transferred from the container to the apparatus, particularly in cases where the wire lock-seal has been broken. In cases where the apparatus is received with the Inerteen installed, the Inerteen should be sampled and tested before the apparatus is put into service, as described later in this book.

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

Although the drums and tank cars are thoroughly washed and dried at the refinery before filling, a certain amount of scale is sometimes loosened from the inside in transit. Therefore, Inerteen which has not been filtered should be strained through three or more thicknesses of muslin, or other closely woven cotton cloth which has been thoroughly washed and dried to remove the sizing. The straining cloths may be stretched across a funnel of large size and should be renewed at frequent intervals.

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.

Important: Always use all-metal hose or pipe when handling the Inerteen. A hose made of natural rubber should not be used. Inerteen can easily become contaminated from the sulphur in the natural rubber, and should not be allowed to come in contact with it.

When it is necessary to transfer Inerteen from warm surroundings to apparatus exposed to extremely cold weather, even when the dielectric strength at room temperature is high, it is desirable to circulate the Inerteen through an Inerteen conditioner at room temperature. A similar procedure is also advisable in the case of apparatus erected inside and later exposed to cold weather, the reason being that Inerteen will absorb more water at higher temperatures which will be thrown out of solution at lower temperatures. The remainder will be in suspension in the Inerteen and will lower the dielectric strength.

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.

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 benzine, 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.

Caution: Do not use a steel pipe because of the danger of a spark igniting the gasoline or benzine vapor.

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 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.

Refilling Drums. 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.

If it is necessary to refill them for storage, drums which have been used only for clean, dry Inerteen should be reserved for this purpose. They should be closed immediately after being emptied, to exclude dirt and water. After refilling, they should be examined to see that they do not leak.

Whenever a drum is to be filled with Inerteen, the temperature of the drum and of the Inerteen should be at least 5.5°C. (10°F.) higher than the air, but the temperature of the drum need not be the same as that of the Inerteen.

A new washer should be used with the bung each time the drum is refilled, to insure a tight seal. These washers may be obtained from the nearest Westinghouse Office and it is recommended that a supply be kept on hand. Natural rubber composition washers should never be used as they would be attacked by the Inerteen.

Drums to be refilled with Inerteen for storage should be plainly marked with paint for identification.

SAMPLING AND INSPECTION

A good fireproof insulating liquid is one that will act as an insulating liquid, will carry the heat away from the apparatus, and is fireproof. Westinghouse Inerteen meets these requirements with the following characteristics:

1. High dielectric strength.
2. Freedom from inorganic acid, alkali, and corrosive sulphur. (To prevent injury to insulation and conductors)
3. Low viscosity. (To provide good heat transfer)
4. Low pour point.
5. Fireproof.

CAUSES OF DETERIORATION

The principal causes of deterioration of Inerteen are:

1. Presence of water.
2. Arcing.

Condensation from moist air due to breathing of the apparatus, especially when the apparatus is not continuously in service, may injure the Inerteen. (The moist air drawn into the apparatus condenses moisture on the surface of the Inerteen and inside of the tank.) The Inerteen may also be contaminated with water through leakage such as from leaky cooling coils or covers.

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. See Reconditioning, Page 7, for the method of purification.

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 carelessness in handling.

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 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. 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.

PERIODIC 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 22 kv, it should be conditioned. If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service" below, and also P.L. 44-860. 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.

INERTEEN 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#1608 629, 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, Pa. 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 methods described under "Testing Methods," which follows and is part of this Instruction Book.

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.)

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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.)

CHARACTERISTICS AND RECONDITIONING

CHARACTERISTICS

Inerteen is chemically stable. It is straw-yellow in color. It 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.

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 under Receiving, Storing, and Handling. (See Page 3.) It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is practically impossible to separate mineral oil and Inerteen.

Inerteen P.D.S. 7336-9 has an improved characteristic so that, when arcing occurs, the insulating materials are not so quickly or so greatly impaired as a result of the liberation of hydrogen chloride. Inerteen 7336-7, which was supplied in Inerteen transformers previous to September 1, 1945, can easily be converted to 7336-9 Inerteen. For complete information on this conversion, request Engineering Data Letter No. 1337-A from any Westinghouse Electric Corporation Office.

Specific Characteristics of Inerteen. As outlined in "Method of Testing Askarels A.S.T.M. D901-49T", 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) 150 A.P.H.
4. Condition: Clear
5. Dielectric constant:
   At 1000 cycles 77°F (25°C), 4.0 to 4.3
   At 1000 cycles 212°F (100°C), 3.5 to 3.8
6. Dielectric strength: (Minimum) 77°F (25°C)
   At point of shipment, 35 kv
   At point of receipt, 30 kv
7. Electrical resistivity: (Minimum)
   100×10^9 ohms/cm^3 (212°F (100°C) at 500 volts d-c)
8. Fixed chlorine content: (Minimum) 59.1 percent
9. Free chlorides: Less than 0.10 ppm
10. Neutralization number: Less than 0.010 mg. of NaOH/gram.
11. Pour point: (Maximum) minus 25.6°F (minus 32°C)
12. Refractive index
    At 77°F (25°C), 1.6137 to 1.6157
13. Specific gravity: (Minimum)
    At 60°F/60°F (15.5°C/15.5°C), 1.560
14. Viscosity: (Maximum)
    At 100°F (37.8°C), 54 seconds

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 (both of which will be explained later in this book under "Apparatus for Reconditioning") 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 naptha. 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 the 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.

TESTING METHODS

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

DIELECTRIC STRENGTH TEST

Apparatus. The testing transformer and the source of supply of energy shall not be less than ½ kva, and the frequency shall not exceed 100 cycles 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 gasoline, 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 1¼ in. below the top of the cup. (A suitable test cup is shown in Fig. 1, and portable testing outfits in Figs. 2, 3, and 4.)

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 gasoline or benzine until they are entirely free from fibers.

The test cup shall be filled with dry, lead-free gasoline or 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 25 kv, 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 gasoline and the test repeated.

Note: Evaporation of gasoline from the electrodes may chill them sufficiently to cause moisture to condense on their surface. For this reason, after the final rinsing with gasoline, the test cup should be immediately filled with the Inerteen which is being tested, and the test made at once, or the electrodes should be thoroughly dried before using.

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.

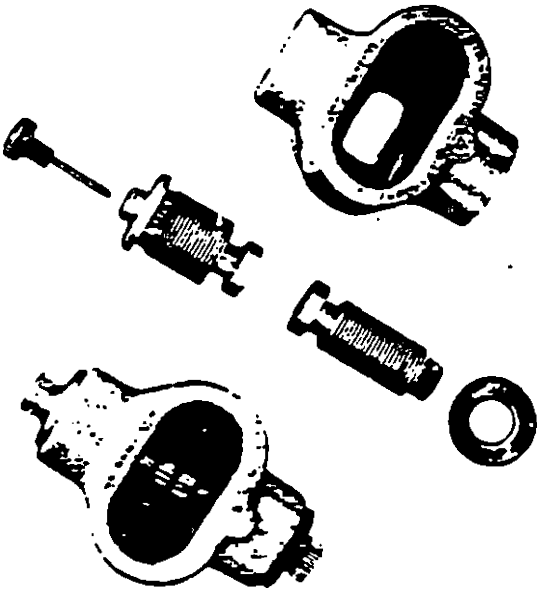

FIG. 1. Fluid Test Cup for Dielectric Test

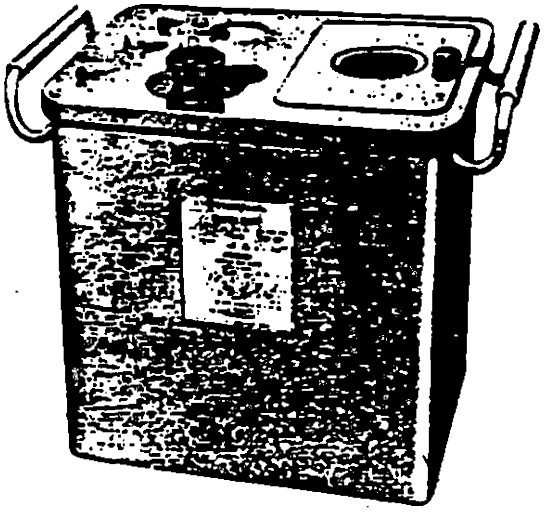

FIG. 2. Portable Oil Testing Set, ½ Kva, 35,000 Volts

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

TESTS

a. Except as specified in (b) 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.

b. 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 (a).

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.

POUR TEST

Note: The procedures covered by the following instructions for the pour test, and especially the neutralization test, require spec-

ial equipment. The neutralization test must be made by a competent chemist, preferably one specializing in this particular field. Customers who do not possess these facilities are offered, at nominal cost, the use of the Westinghouse Inerteen Testing Service. Contact the nearest Westinghouse Office for details.

The pour point of Inerteen is the lowest temperature at which it will pour or flow when it is chilled without disturbance under certain definite specified conditions.

Apparatus. The test jar (see Fig. 4) shall be clear glass, of cylindrical shape, approximately 1¼ in. inside diameter and 4½ to 5 in. high, with a flat bottom. An ordinary 4 oz. Inerteen sample bottle may be used if the test jar is not available.

The cork shall fit the test jar, and shall be bored centrally to accommodate the test thermometer.

The thermometer shall conform to A.S.T.M. specifications for pour test. It may be ordered as: A.S.T.M. thermometer low cloud and pour, -70°F (—56.7°C) to 70°F (+21.1°C).

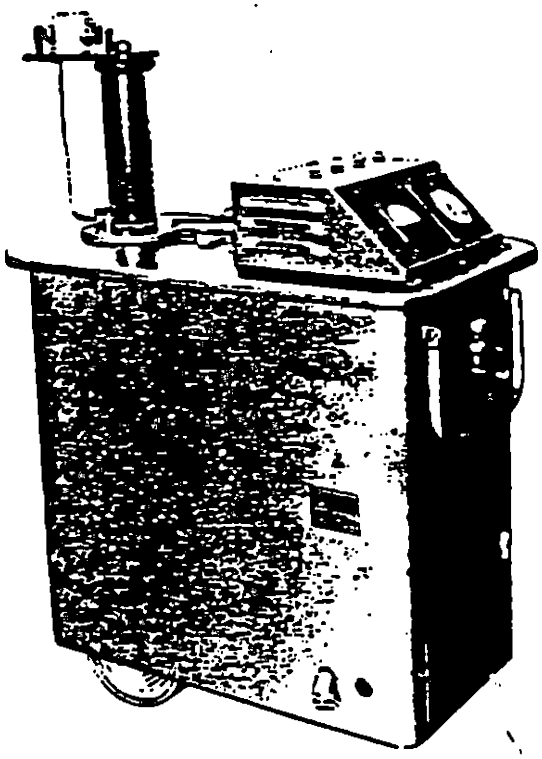

FIG. 3. Portable Trunk Type Insulating Liquid and Insulating Testing Set, 5 Kva, 30,000/60,000 Volts

The jacket shall be of glass or metal and shall be watertight, of cylindrical form, flat bottomed, about 4½ in. deep, with inside diameter ½ in. greater than outside diameter of the test jar.

A disc of cork or felt ¼ in. thick and of the same diameter as the inside of the jacket shall be placed in the bottom of the jacket.

The ring gasket shall be about ⅛ in. thick, made to fit snugly around the outside of the test jar and loosely inside the jacket. This gasket may be made of cork, felt, or other suitable material, elastic enough to cling to the test jar and hard enough to hold its shape. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

The cooling bath shall be of a type suitable for obtaining the required temperature. The size and shape of the bath are optional but a support suitable for holding the jacket firmly in a vertical position is essential. For determination of very low pour points, a smaller insulated cooling bath may be used and the test jar placed directly in it. The required bath temperature may be maintained by refrigeration if available, otherwise by suitable freezing mixtures.

Procedure. The Inerteen to be tested shall be brought to a temperature at least 25°F. (14°C.), above the approximate cloud point. Moisture, if present, shall be removed by any suitable method, as by filtration through dry filter paper until the Inerteen is perfectly clear. (Such filtration shall be made at a temperature at least 25°F. (14°C.), above the approximate cloud point.) The Inerteen shall be poured into the test jar, to a height of not less than 2 in. or more than 2¼ in. When necessary, the Inerteen shall be heated in a water bath just enough so it will pour into the test jar.

The test jar shall be tightly closed by the cork carrying the test thermometer in a vertical position in the center of the jar; the thermometer bulb should be immersed so that the beginning of the capillary shall be ⅛ in. below the surface of the Inerteen.

Heat without stirring to a temperature of 115°F. (46.1°C.) in a bath maintained at not higher than 118°F. (47.8°C.). The Inerteen shall then be cooled to 90°F. (32.2°C.) in air or in a water bath approximately 77°F. (25°C.) in temperature.

The cork or felt disc shall be placed in the bottom of the jacket and the test jar, with the ring gasket, 1 in. above the bottom, shall be inserted into the jacket. The disc, gasket, and inside of jacket shall be clean and dry.

During the cooling of the Inerteen, care shall be taken not to disturb the mass of the Inerteen nor to permit the thermometer to shift in the Inerteen.

The temperature of the cooling bath shall be adjusted so that it is below the pour point—approximately -25.6°F (-32°C)—of the Inerteen by not less than 15°F. (8.3°C) nor more than 30°F. (16.7°C), and the cooling bath shall be maintained at this temperature throughout the test. The jacket containing the test jar shall be supported firmly in a vertical position in the cooling bath so that not more than 1 in. of the jacket projects out of the cooling medium.

Beginning at a temperature 20°F. (11.1°C.) above the expected pour point, at each lower test-thermometer reading which is a multiple of 5°F. (2.8°C), the test jar shall be removed from the jacket carefully and shall be tilted just sufficiently to ascertain whether there is a movement of the Inerteen in the test jar. The complete operation of removal and replacement shall require not more than three seconds. As soon as the Inerteen in the test jar does not flow when the jar is tilted, the test jar shall be held in a horizontal position for exactly five seconds as noted by a stop watch or other accurate timing device, and observed carefully. If the Inerteen shows any movement under these conditions, the test jar shall be immediately replaced in the jacket and the same procedure repeated at the next temperature reading 5°F. (2.8°C.) below the previous reading.

The test shall be continued in this manner until a point is reached at which the Inerteen in the test jar shows no movement when the test jar is held in a horizontal position for exactly five seconds. The reading of the test thermometer at this temperature corrected for error if necessary, shall be recorded. The pour point shall be taken as the temperature 5°F. (2.8°C.) above this solid point.

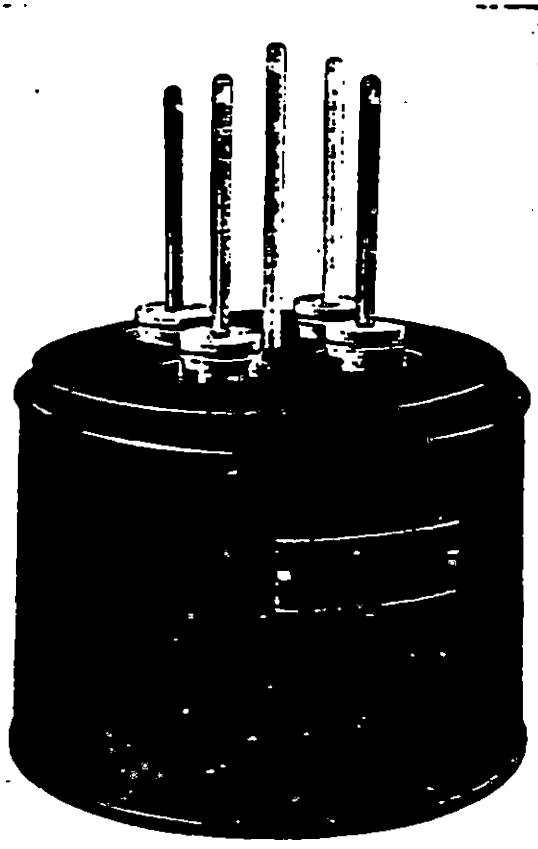

FIG. 4. Apparatus for Pour Test

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, 0.1 N)—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.

c. Alpha-Naphtholbenzein Indicator Solution—Prepare a solution containing 10 g. of alpha-napthol-benzein per liter 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. KOH per g. of Inerteen $= \frac{(A\text{-}B\ (N) \times 56.1}{W}$

A = ml KOH solution required for sample.
B = ml KOH solution required for blank.
N = normality of KOH solution.
W = grams of sample used.

APPARATUS FOR RECONDITIONING

There are several types of reconditioning apparatus available, the relative advantages of each of which are as follows:

1. The Inerteen Conditioner is the most effective method of removing moisture, dirt, and other contaminating materials from Inerteen.

2. The filter press is suitable for treating Inerteen containing only small quantities of water and dirt.

INERTEEN CONDITIONER

The Inerteen Conditioner consists of a clay container, clay filter, a motor-driven positive pressure pump, attendant valves, gauges, and relief devices, all mounted on a common base.

The motor and pump are combined as a unit and a strainer is provided on input to the pump to prevent entrance of large particles. The units are designed to operate under working pressures up to 60 psi. However, the usual operating pressure is 30 psi to 40 psi. Excessive pressures are prevented by two automatic by-pass valves. One by-pass valve connected across the pump is set to by-pass the Inerteen at a pressure of 60 psi to 70 psi. The other by-pass valve is connected on the discharge side of the conditioner. This latter by-pass valve, releasing at a pressure of approximately 5 psi, will avoid breaking the transformer relief diaphragm when no other relief is provided. Pump pressures are indicated by a pressure gauge.

Seven GPM Unit. The activated clay is contained in a tank mounted on one end of the filter frame. This tank is provided with a cover which incorporates an air-trap and vent to remove air which might be present in the tank and piping. The Inerteen is pumped up through the clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through a wire screen prior to entering the paper filter to remove practically all of the clay. The paper filter consists of 18 frames and 17 plates, alternately spaced, mounted in a yoke. One sheet of filter paper is used between each plate and frame to provide a gasket seal and remove all traces of clay from the Inerteen. (See Fig. 8)

Three GPM Unit. This unit utilizes two tanks, one within the other. The activated clay is held in the inner tank by suitable screens at top and bottom. The space below the inner tank is completely sealed off from the rest of the space between the two tanks. The cover is of double-deck construction, incorporating the top screen for the inner tank and the solid cover for the outer tank. The Inerteen is pumped into the lower space and is forced up through the activated clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through the fine mesh upper screen and out into the space between the two tanks. The discharge pipe is at the lower end of the outside tank and any air in the Inerteen is trapped in the upper space of the outside tank where it may be drawn off.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is, therefore, considered advisable to condition Inerteen from the top and return it to the bottom of the Inerteen filled apparatus.

One charge of clay is composed of approximately 40 pounds of 15-30 mesh activated clay.* This relatively large volume of clay makes only occasional changes of clay necessary, depending of course on the amount and condition of the Inerteen filtered. Normally one charge will condition approximately 3000 gallons of Inerteen. The coarse granulated clay used gives maximum surface contact between clay and liquid and makes possible a rapid and thorough mixing of the clay and Inerteen to accomplish complete reconditioning of the Inerteen as it passes through the clay tank. The clay granules are removed from the Inerteen by means of fine screen in the 3 GPM filter and by screen and paper in the 7 GPM filter.

The clay never passes through the pump to cause wear on pump parts and consequent loss of pumping capacity. As soon as the charge of activated clay is placed in the tank and the cover clamped in place, the unit is ready for immediate use.

Neither clay nor filter paper can be effectively dried of water after they have once become saturated with Inerteen. Therefore, extreme care should be taken to see that both clay and filter paper are thoroughly dried when placed in the filter.

The clay may be dried in a high temperature oven at 200 deg. C. for six hours and shallow pans are preferred as containers for the clay while drying. A paper drying oven may be used if a high temperature oven is not available, with a drying time extended to approximately twenty-four hours at the oven's highest temperature. The filter paper should be dried six to twelve hours at 85°C. to 100°C.,

* Filter paper and activated clay may be obtained from the Westinghouse Sharon Plant.

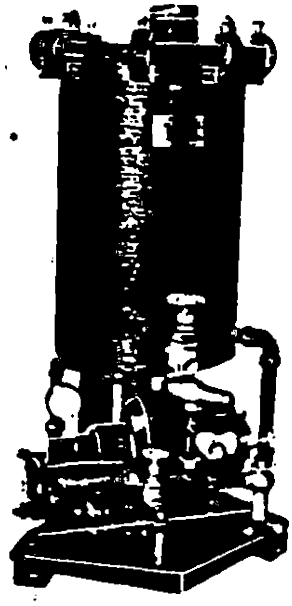

FIG. 5. Three Gallon-per-Minute Conditioner

depending on the condition of the paper and the spacing of the sheets in the oven. Both paper and clay should be placed directly in the filter after the drying process as either, if exposed, will absorb considerable moisture from the atmosphere in a very short time.

Each fresh charge of clay will absorb about three gallons of Inerteen. This should be provided for to prevent depleting the supply in the apparatus, but most of this Inerteen may be recovered when changing clay.

This can be accomplished most effectively by removing the used clay from the filter and placing it in a tank of approximately 30 gallons capacity containing about 5 gallons of water. The tank should have a drain valve at its bottom edge and should be tilted somewhat toward this valve. The clay thus placed in water, having a greater affinity for water, will give up the Inerteen it has absorbed and become saturated with water. The Inerteen being heavier than water will sink to the bottom; the clay and water will float on top. After settling for several hours, most of the Inerteen may be drawn off through the valve. This Inerteen may be reconditioned and used again in recharging the conditioner. The used clay should be discarded.

To Prepare the 7 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the tank with activated clay, 4440-3, to within four inches of the bottom edge of the inner flange. Replace screen and cover. Release the pressure-screw of the filter press and loosen plates and frames. Place one sheet of "B" size blotting paper between the face of each frame and plate. Care should be used to see that the holes thru the plates, frames and paper are in proper alignment before the pressure screw is tightened. Close the discharge, tank by-pass, tank drain, suction and suction-test valves. Open the air discharge valve. Pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons of Inerteen. Start the motor and open the drip pan valve a small amount so that not less than 5 minutes are required to fill the clay tank, saturating the clay with Inerteen. (If Inerteen is admitted too rapidly, it will tend to pack the clay into the top of the tank.) With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge, and drip pan valves.

To begin conditioning Inerteen in Inerteen filled apparatus, open the apparatus valves. Open the conditioner discharge and suction valves. At intervals open air discharge valve to allow trapped air to escape and close when Inerteen starts to flow through valve. Open drip pan valve at intervals too, to remove Inerteen which may have dripped into the drip pan.

When it is necessary to change the clay, first close the valve in the suction line, close the tank

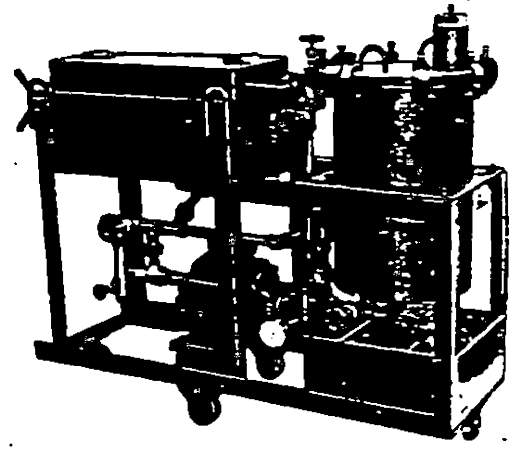

FIG. 6. Seven Gallon-per-Minute Conditioner

inlet and outlet valves, open the tank by-pass valve, the tank drain valve and the air vent valve to permit the free Inerteen in the tank to drain into the lower drip pan. Open the drip pan valve and pump the Inerteen from the drip pan through the filter press. Shut down the motor and remove the clay from the tank and refill with fresh clay as previously described.

To change the filter or blotting papers, stop the motor and close suction and discharge valves. Slowly back off the pressure screw, permitting the Inerteen trapped in the frames to be released gradually. Then back off the pressure screw completely, open up the press and let the surplus Inerteen drain from the papers. Replace the saturated papers with clean dry paper and retighten the press.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to resume conditioning the Inerteen.

To Prepare the 3 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the inner tank with activated clay, 4440-3, to within four inches of the top. Replace screen and cover. Close the discharge and suction valves and open air discharge and drip pan valves about ⅓ open. Start motor and pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons. Not less than five minutes should be required to fill the clay tank and saturate the clay with Inerteen. With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge and drip pan valves.

To begin conditioning Inerteen, open apparatus valves, open the conditioner discharge and suction valves and start motor.

At intervals open air discharge valve to let trapped air escape and close as soon as Inerteen flows from the valve.

When it is necessary to change the clay, first stop motor and close the valves in the suction and discharge lines. Remove discharge hose and open the discharge valve and tank drain valve to permit the Inerteen in the tank and discharge hose to drain into a container. After draining is complete, remove inner tank and dump the clay from the inner tank and refill with fresh clay as previously described. The used clay should be discarded.

BLOTTER FILTER PRESS

The blotter filter press (See Fig. 7) is essentially a number of sets of blotter filter papers in parallel, each set containing several thicknesses. The Inerteen is pumped through filter paper which absorbs the water and strains out the sediment.

Other Classes of Service. Although there are other uses, such as cleaning of low-viscosity insulating compounds, benzine, etc., it is recommended that a cleaning device intended for Inerteen reconditioning should not be used for other classes of work, due to danger of subsequent contamination of the Inerteen.

Capacity. The capacity of these machines, with Inerteen pressure and filtering area fixed, depends on the viscosity of the Inerteen and its freedom from dirt. With fairly clean Inerteen at ordinary room temperature, the capacity of the machines will vary from normal to about 15 percent above normal, depending on the viscosity (which varies with the temperature). It has been found that the best results are obtained when the Inerteen temperature is about 50°C. The average working pressure of these machines is less than 40 psi and the pressure relief valve is set at the factory to by-pass the full flow at from 60 psi to 80 psi.

Apparatus. There are three standard sizes of Westinghouse filter presses: B-5, B-10, and A-30. The letter designates the size of filter paper; the number indicates the relative capacity in gallons per minute.

The complete outfit consists of filterpress, motor, strainer, pump, gas trap, pressure gauge, drip pan, wheels, and piping. The piping is arranged so the line can be tested for leaks under pressure. All machines are mounted on a fabricated structural steel frame. The drip pan can be removed by disconnecting one pipe coupling and four bolts. The strainer can be cleaned by disconnecting three bolts. The pumps are of the helical-gear type to insure quietness and smooth flow of Inerteen. The A-30 pump is connected to the motor through flexible couplings. The B-5 and B-10 pumps are mounted directly on the rear motor bracket and driven through a helical reduction gear.

The filter press proper is made up of a series of cast iron plates and frames assembled alternately, with the filter papers between them. By means of a screw and cast-iron end block, the plates, frames, and papers are forced tightly together. Except for a machined rim which serves as a joint to prevent

the escape of Inerteen, the plates are cast with small pyramids on both surfaces.

The plates and frames have holes in two corners and supporting lugs at the sides. The plates have handles cast on the top edge. When the plates and frames are assembled with the filter papers between, the holes form the inlet and outlet. The frames have the holes in the upper corner connected by small ducts to the middle of the frame. The plates have ducts leading from the surface of the plate to the hole in the lower corner. (See Fig. 8)

The Inerteen enters under pressure at the top corner through the inlet formed by the holes in the frames, plates, and filter papers, flows into the frames through the same ducts, and completely fills the chamber formed by the frame and two sets of filter paper. As there are no outlet ducts in the frame, the Inerteen is forced through the paper and flows along the grooves between the rows of pyramids and out through the ducts provided at the lower corner of the plates. The dry filter paper takes up the moisture and removes the sediment from the Inerteen.

Operation. The filter press is made ready for operation by placing a set of five sheets of filter paper (that have been thoroughly dried in an electric oven) between each filter plate and frame. The holes in the filter paper must line up with the holes in the plates and frames. The sediment is strained out by the first layer of paper and the moisture is taken up by the capillary action of the paper.

If any moisture remains, it indicates that the filter papers are saturated with moisture and should be renewed. No rule can be given as to how often the papers must be changed, as this depends entirely on the condition of the Inerteen. The usual procedure is to run the machine for about half an hour (if the Inerteen is not in very bad condition) and then shut down; remove one sheet from the inlet side of each set and put in a new sheet on the outlet side of each set. (The frame is the inlet side and the plate is the outlet side.) Frequent dielectric tests should be made during this procedure as wet Inerteen may necessitate recharging the filter press with a full set of papers before the five sheets have been removed in succession.

The quickest method of filtering a quantity of Inerteen is to pump all the Inerteen through the filter and into another tank which is clean and dry. If care is taken to change the filter papers before they become saturated, the Inerteen will be clean and dry. If a second tank for holding the Inerteen

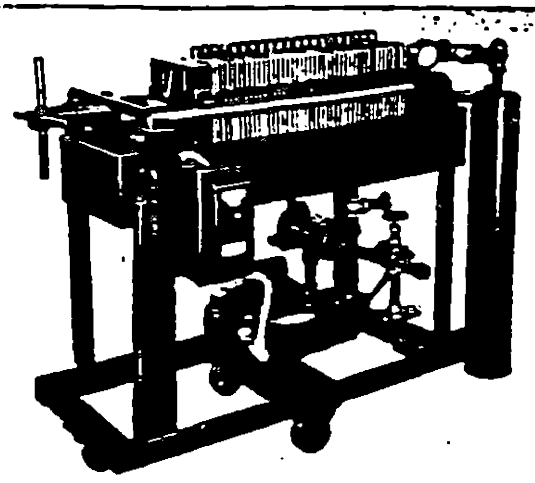

FIG. 7. B-10 Blotter Filter Press

is not available, or if it is desired to filter the Inerteen of apparatus while it is in service, the Inerteen may be pumped from the top of the apparatus tank through the filter and returned to the bottom of the same tank under the surface of the Inerteen. This operation should be continued until the Inerteen in the apparatus tank shows a sufficiently high dielectric strength.

When a large quantity of Inerteen is to be filtered, time may be saved by using two filter presses, one of which may be operated while the other is being recharged.

Filtering through blotter filter papers does not materially reduce organic acidity or improve resistance to emulsification, although the dielectric strength may be restored to a satisfactory value.

The capacity of the filter press is much reduced when operating at low temperatures.

When the Inerteen has to be filtered at low temperatures, an additional pump in the pipe line is desirable.

Inerteen in apparatus contaminated by only a small amount of moisture may be reconditioned by drawing the Inerteen from the top of the apparatus tank, passing it through the filter press, and pumping it back into the bottom of the apparatus. The Inerteen should be put through the system until a sample drawn from the top of the apparatus gives satisfactory dielectric values.

Blotter Filter Paper. The filter paper used is a special grade of blotting paper about .025 in. thick; it contains no coloring matter or chemicals which might injure the Inerteen. Five sheets cut to

the proper size, 12⅞ in. square for the A sizes and 7¾ in. square for the B sizes, and with holes punched to correspond with the holes in the plates and frames, are used between each plate and the adjacent frames.

To obtain the best results in reconditioning Inerteen, the paper must be perfectly dry when first placed in the press. Filter paper always takes up moisture if exposed to the air for any length of time and for this reason care must be used in handling. The standard paper is carried in packages containing one ream, carefully wrapped in waxed paper and covered with heavy wrapping paper.

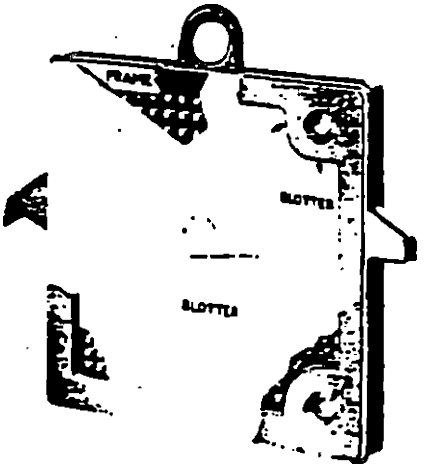

FIG. 8. Blotter Filter Press Frame Showing Blotter Filter Papers in Place

Electric Drying Ovens. Electric drying ovens for use with Type A and Type B filter presses require 2000 watts and 1400 watts respectively. The interior of the ovens is provided with rods for supporting the filter paper to facilitate rapid and thorough drying. An automatic thermostat having a range of 65°C to 120°C is provided for maintaining uniform oven temperature. The thermostat is adjusted at the factory for 100°C, the recommended value, and the setting marked so that the operator may conveniently reset thermostat to 100°C if adjustment is changed.

The standard thermostat-equipped oven is suitable for alternating current only. Ovens to operate on direct current are special and are equipped with a thermometer and a manually operated three-heat switch.

By moving one rod, the Type A oven can be used for drying Type B paper.

The normal capacity of the Type A oven is 240 sheets and the Type B oven is 180 sheets when spaced ¼ inch apart.

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SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SAN ANTONIO 3, TEXAS, 115 W. Travis St.
SAN DIEGO 1, CALIF., 525 "B" St.
SAN FRANCISCO 8, CALIF., 410 Bush St.
SAVANNAH, GA., 204 Realty Bldg., P.O. Box 2008
SEATTLE 4, WASH., 3451 East Marginal Way
SHREVEPORT, LA., 412 Milam St.
SIOUX CITY 7, IOWA, 1005 Dane St.
SOUTH BEND 4, IND., 216 East Wayne St.
SPARTANBURG, S. C., 331 High Point Road, P.O. Box 269
SPOKANE 1, WASH., North 1023 Monroe St.
SPRINGFIELD, ILL., 607 E. Adams St., P.O. Box 37
SPRINGFIELD 3, MASS., 26 Vernon St.
SYRACUSE 4, N. Y., 700 W. Genesee St.
TACOMA 2, WASH., 1930 Pacific Ave.
TAMPA, FLA., 608 Tampa St.
TOLEDO 4, OHIO, 245 Summit St.
TRENTON 8, N. J., 28 W. State St.
TULSA 3, OKLA., 800 S. Main St.
UTICA 2, N. Y., 253-257 N. Genesee St.
WALLA WALLA, WASH., Denny Bldg., P.O. Box 182
WASHINGTON 6, D. C., 1625 "K" St., N.W.
WATERLOO, IOWA, 300 West 3rd St.
WATERTOWN, N. Y., 245 State St.
WHEELING, W. VA., 12th and Main St. (Nat'l. Bank of W. Va.)
WICHITA, KANS., 211 So. Main St.
WILKES-BARRE, PA., 287 N. Pennsylvania Ave.
WILLIAMSPORT, PA., 221 Williamsport Bldg., 480 Market St.
WORCESTER 8, MASS., 507 Main St.
YORK, PA., 11 W. Market St.
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.

MANUFACTURING AND REPAIR DEPT. OFFICES

ATLANTA 2, GA., 1103 Pitcher St., N.W.
ATLANTA 2, GA., 1299 Northside Drive, N. W., P.O. Box 4808
AUGUSTA, MAINE, 9 Bowman St.
BALTIMORE 24, MD., 4013 Fenner Ave.
BATON ROUGE 2, LA., 855 Chestnut Drive, P.O. Box 1190
BIRMINGHAM 8, ALA., 3401 Third Ave., S.
BOSTON 27, MASS., 235 Old Colony Ave. (So. Boston)
BRIDGEPORT 8, CONN., 540 Grant St.
BROOKLYN 6, N. Y., 1 Hanover Place (Windsor M & R Corp.)
BUFFALO 10, N. Y., 1132 Seneca St.
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO 32, ILL., 3900 W. 41st St.
CINCINNATI 37, OHIO, 1080 Ludlow Ave., P.O. Box 40
CLEVELAND 2, OHIO, 2801 Broadway Ave., Station A
DENVER 19, COLO., 300 So. Grande Blvd.
DETROIT 32, MICH., 5757 Trumbull Ave., P.O. Box 302
DULUTH 8, MINN., 8220 Grand Ave.
EMERYVILLE 8, CALIF., 3840 Landregan St.
FAIRMONT, W. VA., 10th and Beltline Sts., P.O. Box 1147
FORT WORTH 7, TEXAS, 100 Report St.
HILLSIDE 8, N. J., 1441 Chestnut Ave.
HOUSTON 20, TEXAS, 5730 Clinton Dr.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1190
INDIANAPOLIS 25, IND., 531 West Merrill St., P.O. Box 1535
JOHNSTOWN, PA., 107 Station St.
KANSAS CITY 6?, MO., 1300 Oak St.
LOS ANGELES, CALIF., 2383 E. Gage Ave., P.O. Box 629, Huntington Park
MILWAUKEE 9, WIS., 1900 W. Cornell St.
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N. E.
PHILADELPHIA 4, PA., 3001 Walnut St.
PHILADELPHIA 34, PA., Erie Ave. & "D" St.
PITTSBURGH 8, PA., 843 N. Lang Ave.
PORTLAND 12, ORE., 626 North Tillamook St.
PROVIDENCE 3, R. I., 16 Elbow St.
ST. LOUIS 10, MO., 1601 S. Vandeventer Ave.
SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SEATTLE 4, WASH., 3451 East Marginal Way
SPRINGFIELD 1, MASS., 326 Liberty St.
SUNNYVALE, CALIF. (Sunnyvale Plant), P.O. Box 37
SYRACUSE 4, N. Y., 700 West Genesee St.
UTICA 1, N. Y., 113 W. Genesee St.
WILKES-BARRE, PA., 287 N. Pennsylvania Ave.

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ATLANTA 2, GA., 1299 Northside Drive, N. W., P.O. Box 4808
BALTIMORE 2, MD., 201 St. Paul Pl.
BEAUMONT, TEXAS, 515 American National Bank Bldg.
BIRMINGHAM 3, ALA., 1407 Comer Bldg.
BOSTON 10, MASS., 10 High St.
BUFFALO 3, N. Y., Ellicott Square Bldg.
BUTTE, MONT., 1 East Broadway
CHARLOTTE 1, N. C., 210 East Sixth St.
CHICAGO, ILL., Merchandise Mart Plaza
CINCINNATI 2, OHIO, 207 West Third St.
CLEVELAND 13, OHIO, 1370 Ontario St.
COLUMBUS 15, OHIO, 262 N. 4th St.
DALLAS 1, TEXAS, 1232 Fidelity Union Life Bldg.
DAVENPORT, IOWA, 2212 E. 12th St.
DENVER, COLO., 910 Fifteenth St.
DES MOINES 8, IOWA, 1408 Walnut St.
DETROIT 32, MICH., 5757 Trumbull Ave., P.O. Box 302
DULUTH 2, MINN., 408 Bradley Bldg., 10 East Superior St.
EL PASO, TEXAS, 718 Mills Bldg.
FRESNO 1, CALIF., 2808 Californian Ave.
GRAND RAPIDS 2, MICH., 148 Monroe Ave., N. W.
HARTFORD 3, CONN., 119 Ann St.
HOUSTON 2, TEXAS, 907 Dallas Ave.
HUNTINGTON 1, W. VA., 1029 Seventh Ave., P.O. Box 1190
INDIANAPOLIS 9, IND., 137 S. Pennsylvania St.
JACKSON, MICH., 120 W. Michigan Ave.
KANSAS CITY 6, MO., 101 W. Eleventh St.
LOS ANGELES 17, CALIF., 600 St. Paul Ave.
LOUISVILLE 2, KY., 332 West Broadway
MEMPHIS 3, TENN., 825 Exchange Bldg., 130 Madison Ave.
MILWAUKEE 2, WIS., 538 N. Broadway
MINNEAPOLIS 13, MINN., 2303 Kennedy St., N. E.
NEWARK 2, N. J., 1180 Raymond Blvd.
NEW ORLEANS 12, LA., 1226 Whitney Bldg., 288 St. Charles St.
NEW YORK 3, N. Y., 40 Wall St.
NORFOLK 10, VA., 815 W. 21st St.
OMAHA 2, NEBR., 117 N. 13th St.
PHILADELPHIA 4, PA., 3001 Walnut St.
PHOENIX, ARIZ., 1102 N. 21st Ave., P.O. Box 6144
PITTSBURGH 30, PA., 306 4th Ave., P.O. Box 1017
PORTLAND 4, ORE., 309 S.W. 6th Ave.
RICHMOND 19, VA., 1110 East Main St.
ROANOKE 4, VA., 303 1st St. S.W.
ST. LOUIS, MO., 411 North Seventh St.
SALT LAKE CITY 1, UTAH, 235 W. South Temple St.
SAN DIEGO 1, CALIF., 525 "B" St.
SAN FRANCISCO 8, CALIF., 410 Bush St.
SEATTLE 4, WASH., 3451 East Marginal Way
SPOKANE 1, WASH., N. 1023 Monroe St.
SYRACUSE 4, N. Y., 700 W. Genesee St.
TOLEDO 4, OHIO, 245 Summit St.
UTICA 2, N. Y., 255-257 Genesee St.
WASHINGTON 6, D. C., 1625 "K" Street, N.W.
WILKES-BARRE, PA., 287 N. Pennsylvania Ave.
YOUNGSTOWN 3, OHIO, 25 E. Boardman St.

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Instructions for INERTEEN® Insulating Fluid P.D.S. 54201 KA

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Westinghouse Exhibit 6

Westinghouse Electric Corporation
Power Transformer Division, Sharon, Pa.
I.B. 44.063.00 [illegible] July 1964 Supersedes I.B. [illegible]

INERTEEN* INSULATING FLUID

P.D.S. 54201KA

Inerteen is a synthetic non-inflammable and non-explosive insulating and cooling liquid. It has proved its suitability for use in all Westinghouse Inerteen insulated apparatus. In order to insure the proper performance of the apparatus, only Westinghouse Inerteen should be used.

This publication gives the instructions for handling, inspection, and maintenance which experience has shown are important in obtaining the best service from the Inerteen.

* Registered trade-mark for Westinghouse Askarel.

RECEIVING, HANDLING, STORING

SHIPMENT

Inerteen is shipped in tank cars, drums, or cans. The modern tank cars are usually lagged to prevent rapid fluctuations in temperature during transit and thus reduce the amount of expansion and contraction of Inerteen. Changes in the volume of the Inerteen due to temperature changes tend to cause breathing in of moist air resulting in condensation of moisture inside the container, and lowering of the dielectric strength of the Inerteen.

When shipped in drums, the Inerteen and the drums are both heated above room temperature while the drums are being filled, and the bungs are tightened immediately after filling. After cooling to normal temperature, the bungs are again tightened. The drums are provided with screw bungs having gaskets to prevent admission of water.

When shipped in cans, the cans as well as the Inerteen are heated above room temperature while being filled and are hermetically sealed immediately after filling.

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. If loosened, be sure Inerteen is tested before using, or combining it with good Inerteen.

It is very desirable that Inerteen in drums be stored in a closed room. 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, protection against direct contact of rain and snow should be provided. Drums stored outdoors should be placed so that bungs will be protected from moisture. It is desirable to cover the drums with a tarpaulin.

Cans. Cans containing Inerteen must not be exposed to the weather. Seals should be kept intact until the Inerteen is actually needed.

Screw caps are provided on the cans to use when the Inerteen is only partially removed after hermetic seal has been broken. By replacing the screw caps contamination by moisture and dirt will be retarded but the Inerteen must be tested just before using.

Storage Tank. The storage tank should be mounted on piers so that it will not touch the ground and will be accessible to all points for inspection for leakage.

It is desirable to maintain the temperature of the Inerteen and tank a little above the temperature of the surrounding air as this prevents condensation of moisture in the tank which would affect the dielectric strength of the Inerteen.

The tank should preferably have a convex bottom allowing for the installation of a drain cock at the lowest point for removing dirt or tank scale which might settle out. As Inerteen is heavier than water most all of any water present will, in time rise to the top of the Inerteen. A valve somewhere near the normal top level of the Inerteen should be provided for drawing off water-contaminated Inerteen. Provision for drawing off the Inerteen should also be made near the bottom of the tank.

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HANDLING

Caution: Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor particularly when it is hot, should be avoided. Especially the eyes, nose, and lips are affected when Inerteen comes in contact with them. Certain safety precautions must be observed when handling Inerteen.

In case Inerteen comes in contact with the skin the parts affected should be thoroughly washed in soapy water and followed by an application of cold cream. A supply of these materials should be kept available at all times where persons are working with Inerteen. Continued exposure may cause eruptions on certain individuals due to the absorption of Inerteen through the pores

the skin. Cleanliness among workmen handling Inerteen is a very good safeguard against such effects. Application of castor oil is recommended for the eyes, castor oil or cold cream for the nose and lips.

Hot apparatus should not be opened except in well-ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, the clothing should be changed as soon as possible and the soiled clothing laundered before it is worn again. Gloves such as Westinghouse S#1309 974 should be worn when it is necessary to put one's hand into Inerteen or when parts of apparatus must be handled wet.

Mineral oil is completely miscible with Inerteen and it is practically impossible to separate them. Therefore, it is important to avoid contaminating Inerteen with any kind of oil, since its presence changes the non-inflammable and non-explosive acteristics of Inerteen.

Note: The Inerteen should be sampled and tested before being transferred from the container to the apparatus, particularly in cases where the wire lock-seal has been broken. In cases where the apparatus is received with the Inerteen installed, the Inerteen should be sampled and tested before the apparatus is put into service, as described later in this book.

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

Although the drums and tank cars are thoroughly washed and dried at the refinery before filling, a ertain amount of scale is sometimes loosened from ce inside in transit. Therefore, Inerteen which has ot been filtered should be strained through three or ore thicknesses of muslin, or other closely woven otton cloth which has been thoroughly washed and ried to remove the sizing. The straining cloths may e stretched across a funnel of large size and should e renewed at frequent intervals.

portant: Extreme precautions must be ken to insure the absolute dryness and eanliness of the apparatus before filling it ith Inerteen, and to prevent the entrance of ater and dirt during the transfer of the Iner- en 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.

Important: Always use all-metal hose or pipe when handling the Inerteen. A hose made of natural rubber should not be used. Inerteen can easily become contaminated from the sulphur in the natural rubber, and should not be allowed to come in contact with it.

When it is necessary to transfer Inerteen from warm surroundings to apparatus exposed to extremely cold weather, even when the dielectric strength at room temperature is high, it is desirable to circulate the Inerteen through an Inerteen conditioner at room temperature. A similar procedure is also advisable in the case of apparatus erected inside and later exposed to cold weather, the reason being that Inerteen will absorb more water at higher temperatures which will be thrown out of solution at lower temperatures. The remainder will be in suspension in the Inerteen and will lower the dielectric strength.

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.

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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 benzine, 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.

Caution: Do not use a steel pipe because of the danger of a spark igniting the gasoline or benzine vapor.

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 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.

Refilling Drums. 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.

If it is necessary to refill them for storage, drums which have been used only for clean, dry Inerteen should be reserved for this purpose. They should be closed immediately after being emptied, to exclude dirt and water. After refilling, they should be examined to see that they do not leak.

Whenever a drum is to be filled with Inerteen, the temperature of the drum and of the Inerteen should be at least 5.5°C. (10°F.) higher than the air, but the temperature of the drum need not be the same as that of the Inerteen.

A new washer should be used with the bung each time the drum is refilled, to insure a tight seal. These washers may be obtained from the nearest Westinghouse Office and it is recommended that a supply be kept on hand. Natural rubber composition washers should never be used as they would be attacked by the Inerteen.

Drums to be refilled with Inerteen for storage should be plainly marked with paint for identification.

SAMPLING AND INSPECTION

A good fireproof insulating liquid is one that will act as an insulating liquid, will carry the heat away from the apparatus, and is fireproof. Westinghouse Inerteen meets these requirements with the following characteristics:

1. High dielectric strength.
2. Freedom from inorganic acid, alkali, and corrosive sulphur. (To prevent injury to insulation and conductors)
3. Low viscosity. (To provide good heat transfer)
4. Low pour point.
5. Fireproof.

CAUSES OF DETERIORATION

The principal causes of deterioration of Inerteen are:

1. Presence of water.
2. Arcing.

Condensation from moist air due to breathing of the apparatus, especially when the apparatus is not continuously in service, may injure the Inerteen. (The moist air drawn into the apparatus condenses moisture on the surface of the Inerteen and inside of the tank.) The Inerteen may also be contaminated with water through leakage such as from leaky cooling coils or covers.

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. See Reconditioning, Page 7, for the method of purification.

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 carelessness in handling.

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

irable that samples of Inerteen be removed from ny container on clear days only, and when the emperature of the Inerteen is at least as high as the emperature of the surrounding air.

Use only tin containers with screwed metal caps or glass bottles with Inerteen-resistant stoppers to nold Inerteen samples. If it becomes necessary to use other than factory sampling containers, they should be rinsed with clean naptha, washed with strong soap suds, and rinsed thoroughly in hot water, and then dried at approximately 110°C. for our hours with neck down in a circulating air oven. f the containers are not used immediately after cleaning, they should be sealed tightly and stored a dry, clean place.

Provision is made on all Inerteen transformers to obtain a top sample of the Inerteen, however on a ransformer that is in operation, a sample may be aken from either the top or bottom since any noisture present will be mixed in, due to circula- ion of the Inerteen. In sampling, allow a small mount of Inerteen to run out to flush the sampling onnection clean before collecting the sample. The een should be put into the sample containers mmediately and the caps screwed on tightly. The abel for each container should be marked clearly ith the serial number of the transformer or com- artment from which the Inerteen was taken.

Before taking samples from a storage tank, the nerteen should be allowed to settle for approxi- ately twelve hours so that if there is any moisture resent, it, having a lower specific gravity, will rise the top where the sample is to be taken. A clean eak-thief should be used to obtain the samples. ssentially, the same precautions to prevent mois- re and dirt contamination should be used as out- ed above.

Quantity of Sample. It is recommended that ne 16 oz. bottle of Inerteen be taken as a sample for sting. At least one sample should be taken from tank car of Inerteen. One sample may be taken om each drum, or if desired, a composite sample ay be made from Inerteen from five drums, pro- ded all of the drums are airtight. When the bung first loosened, a hissing sound should be heard, ich indicates that the drum has been airtight. If est of the composite sample is not satisfactory, a mple from each of the drums represented should tested.

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

PERIODIC 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 22 kv, it should be conditioned. If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service" below, and also P.L. 44-860. 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.

INERTEEN 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# 1608 629, 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, Pa. 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 methods described under "Testing Methods," which follows and is part of this Instruction Book.

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.)

CHARACTERISTICS AND RECONDITIONING

CHARACTERISTICS

Inerteen is chemically stable. It is straw-yellow in color. It 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.

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 caution note under Receiving, Storing, and Handling. (See Page 3.) It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is practically 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) 400 A.P.H.
4. Condition: Clear
5. Dielectric constant:
   At 1000 cycles 77°F (25°C), 4.0 to 4.3
   At 1000 cycles 212°F (100°C), 3.5 to 3.8
6. Dielectric strength: (Minimum) 77°F (25°C)
   At point of shipment, 35 kv
   At point of receipt, 30 kv
7. Electrical resistivity: (Minimum)
   100×10^6 ohms/cm³ (212°F (100°C) at 500 volts d-c)
8. Fixed chlorine content: (Minimum) 59.1 percent
9. Free chlorides: Less than 0.10 ppm
10. Neutralization number: Less than 0.014 mg. of NaOH/gram.
11. Pour Point: (Maximum) minus 25.6°F (minus 32°C)
12. Refractive index
    At 77°F (25°C), 1.6140 to 1.6160
13. Specific gravity:
    At 60°F/60°F (15.5°C/15.5°C), 1.513 to 1.526
14. Viscosity:
    At 100°F (37.8°C), 56 seconds ±2

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 (both of which will be explained later in this book under "Apparatus for Reconditioning") 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.

TESTING METHODS

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

DIELECTRIC STRENGTH TEST

Apparatus. The testing transformer and the source of supply of energy shall not be less than ½ kva, and the frequency shall not exceed 100 cycles 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 gasoline, 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 1¼ in. below the top of the cup. (A suitable test cup is shown in Fig. 1, and portable testing outfits in Figs. 2, 3 and 4.)

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 gasoline or benzine until they are entirely free from fibers.

The test cup shall be filled with dry, lead-free gasoline or 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 25 kv, 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 gasoline and the test repeated.

Note: Evaporation of gasoline from the electrodes may chill them sufficiently to cause moisture to condense on their surface. For this reason, after the final rinsing with gasoline, the test cup should be immediately filled with the Inerteen which is being tested, and the test made at once, or the electrodes should be thoroughly dried before using.

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.

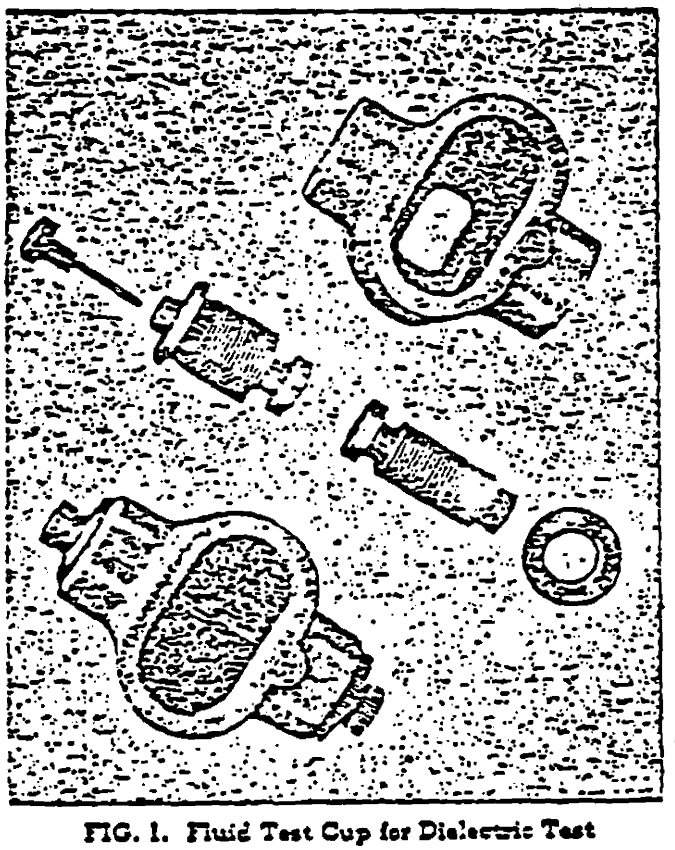
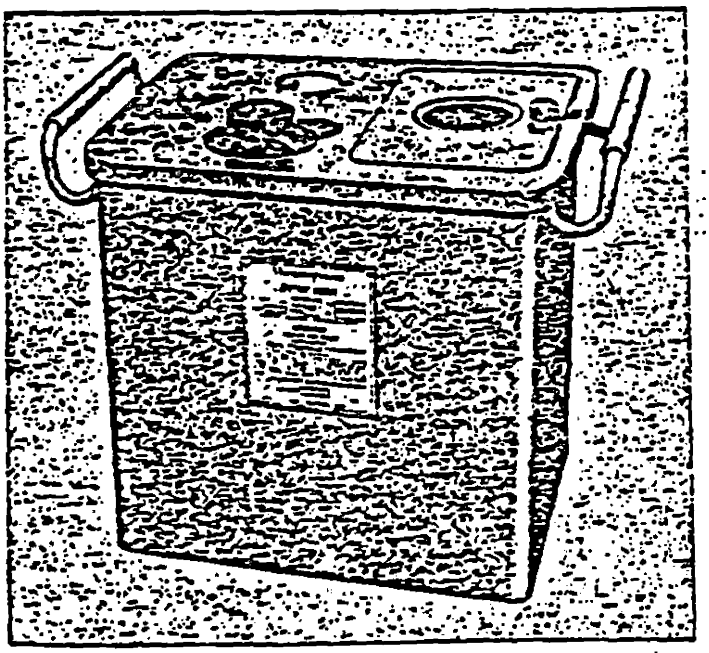


FIG. 1. Fluid Test Cup for Dielectric Test



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

TESTS

a. Except as specified in (b) 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.

b. 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 (a).

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.

500545 POUR TEST

Note: The procedures covered by the following instructions for the pour test, and especially the neutralization test, require

ment. The neutralization test must be made by a competent chemist, preferably one specializing in this particular field. Customers who do not possess these facilities are offered, at nominal cost, the use of the Westinghouse Inerteen Testing Service. Contact the nearest Westinghouse Office for details.

The pour point of Inerteen is the lowest temperature at which it will pour or flow when it is chilled without disturbance under certain definite specified conditions.

Apparatus. The test jar (see Fig. 4) shall be clear glass, of cylindrical shape, approximately 1¼ in. inside diameter and 4½ to 5 in. high, with a flat bottom. An ordinary 4 oz. Inerteen sample bottle may be used if the test jar is not available.

The cork shall fit the test jar, and shall be bored centrally to accommodate the test thermometer.

The thermometer shall conform to A.S.T.M. specifications for pour test. It may be ordered as: A.S.T.M. thermometer low cloud and pour, —70°F (—56.7°C) to 70°F (+21.1°C).

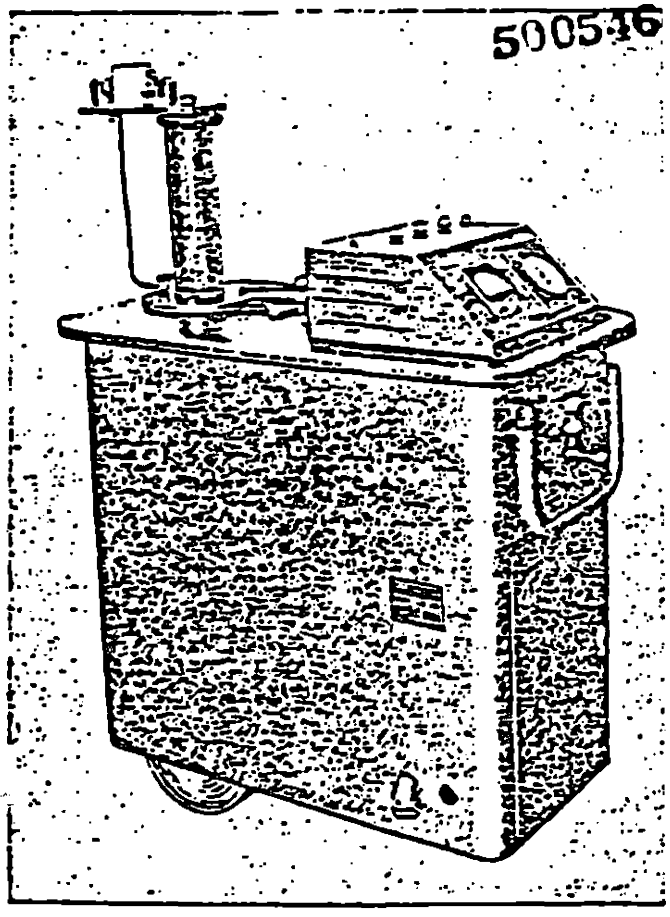


FIG. 3. Portable Trunk Type Insulating Liquid and Insulating Testing Set, 5 Kva, 30,000/60,000 Volts

The jacket shall be of glass or metal and shall be watertight, of cylindrical form, flat bottomed, about 4½ in. deep, with inside diameter ½ in. greater than outside diameter of the test jar.

A disc of cork or felt ¼ in. thick and of the same diameter as the inside of the jacket shall be placed in the bottom of the jacket.

The ring gasket shall be about 1/16 in. thick, made to fit snugly around the outside of the test jar and loosely inside the jacket. This gasket may be made of cork, felt, or other suitable material, elastic enough to cling to the test jar and hard enough to hold its shape. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

The cooling bath shall be of a type suitable for obtaining the required temperature. The size and shape of the bath are optional but a support suitable for holding the jacket firmly in a vertical position is essential. For determination of very low pour points, a smaller insulated cooling bath may be used and the test jar placed directly in it. The required bath temperature may be maintained by refrigeration if available, otherwise by suitable freezing mixtures.

Procedure. The Inerteen to be tested shall be brought to a temperature at least 25°F. (14°C.), above the approximate cloud point. Moisture, if present, shall be removed by any suitable method, as by filtration through dry filter paper until the Inerteen is perfectly clear. (Such filtration shall be made at a temperature at least 25°F. (14°C.), above the approximate cloud point.) The Inerteen shall be poured into the test jar, to a height of not less than 2 in. or more than 2¼ in. When necessary, the Inerteen shall be heated in a water bath just enough so it will pour into the test jar.

The test jar shall be tightly closed by the cork carrying the test thermometer in a vertical position in the center of the jar; the thermometer bulb should be immersed so that the beginning of the capillary shall be 1/8 in. below the surface of the Inerteen.

Heat without stirring to a temperature of 115°F. (46.1°C.) in a bath maintained at not higher than 118°F. (47.8°C.). The Inerteen shall then be cooled to 90°F. (32.2°C.) in air or in a water bath approximately 77 F. (25 C.) in temperature.

The cork or felt disc shall be placed in the bottom of the jacket and the test jar, with the ring gasket, 1 in. above the bottom, shall be inserted into the jacket. The disc, gasket, and inside of jacket shall be clean and dry.

During the cooling of the Inerteen, care shall be taken not to disturb the mass of the Inerteen nor to permit the thermometer to shift in the Inerteen.

The temperature of the cooling bath shall be adjusted so that it is below the pour point—approximately -25.6°F (-32°C)—of the Inerteen by not less than 15°F. (8.3°C) nor more than 30°F. (16.7°C), and the cooling bath shall be maintained at this temperature throughout the test. The jacket containing the test jar shall be supported firmly in a vertical position in the cooling bath so that not more than 1 in. of the jacket projects out of the cooling medium.

Beginning at a temperature 20°F. (11.1°C.) above the expected pour point, at each lower test-thermometer reading which is a multiple of 5°F. (2.8°C), the test jar shall be removed from the jacket carefully and shall be tilted just sufficiently to ascertain whether there is a movement of the Inerteen in the test jar. The complete operation of removal and replacement shall require not more than three seconds. As soon as the Inerteen in the test jar does not flow when the jar is tilted, the test jar shall be held in a horizontal position for exactly five seconds, as noted by a stop watch or other accurate timing device, and observed carefully. If the Inerteen shows any movement under these conditions, the test jar shall be immediately replaced in the jacket and the same procedure repeated at the next temperature reading 5°F. (2.8°C.) below the previous reading.

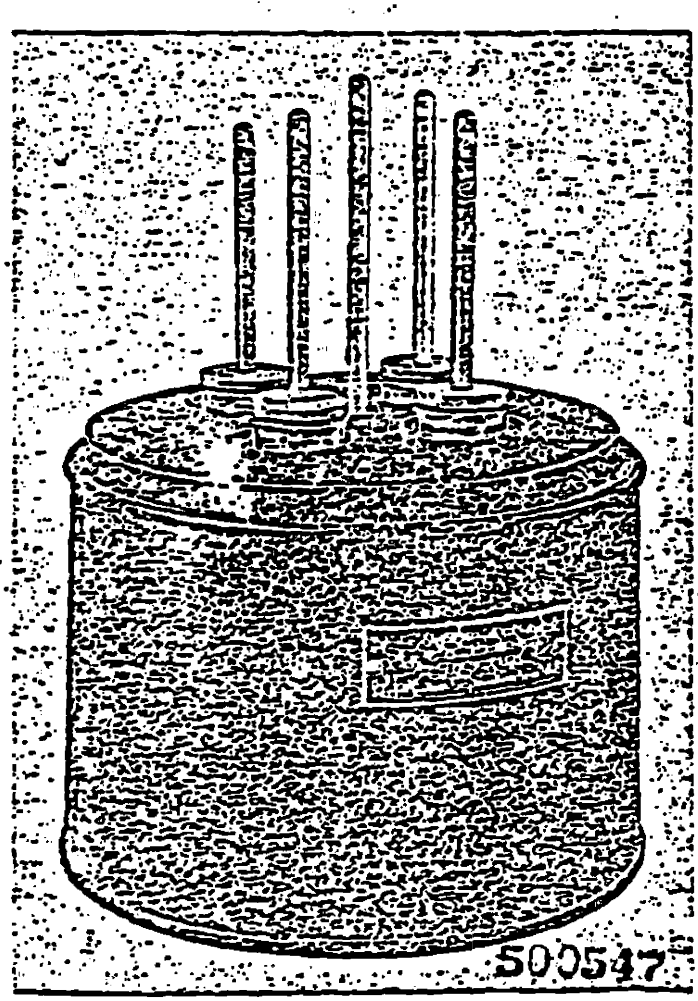


FIG. 4. Apparatus for Pour Test

The test shall be continued in this manner until a point is reached at which the Inerteen in the test jar shows no movement when the test jar is held in a horizontal position for exactly five seconds. The reading of the test thermometer at this temperature, corrected for error if necessary, shall be recorded. The pour point shall be taken as the temperature 5 F. (2.8 C.) above this solid point.

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, 0.1 N)—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.

c. Alpha-Naphtholbenzein Indicator Solution—Prepare a solution containing 10 g. of alpha-naphtholbenzein per liter 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. KOH per g. of Inerteen = $\frac{(A\text{-}B\ (N) \times 56.1}{W}$

A = ml KOH solution required for sample.
B = ml KOH solution required for blank.
N = normality of KOH solution.
W = grams of sample used.

APPARATUS FOR RECONDITIONING

There are several types of reconditioning apparatus available, the relative advantages of each of which are as follows:

1. The Inerteen Conditioner is the most effective method of removing moisture, dirt, and other contaminating materials from Inerteen.

2. The filter press is suitable for treating Inerteen containing only small quantities of water and dirt.

INERTEEN CONDITIONER

The Inerteen Conditioner consists of a clay container, clay filter, a motor-driven positive pressure pump, attendant valves, gauges, and relief devices, all mounted on a common base.

The motor and pump are combined as a unit and a strainer is provided on input to the pump to prevent entrance of large particles. The units are designed to operate under working pressures up to 60 psi. However, the usual operating pressure is 30 psi to 40 psi. Excessive pressures are prevented by two automatic by-pass valves. One by-pass valve connected across the pump is set to by-pass the Inerteen at a pressure of 60 psi to 70 psi. The other by-pass valve is connected on the discharge side of the conditioner. This latter by-pass valve, releasing at a pressure of approximately 5 psi, will avoid breaking the transformer relief diaphragm when no other relief is provided. Pump pressures are indicated by a pressure gauge.

Seven GPM Unit. The activated clay is contained in a tank mounted on one end of the filter frame. This tank is provided with a cover which incorporates an air-trap and vent to remove air which might be present in the tank and piping. The Inerteen is pumped up through the clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through a wire screen prior to entering the paper filter to remove practically all of the clay. The paper filter consists of 18 frames and 17 plates, alternately spaced, mounted in a yoke. One sheet of filter paper is used between each plate and frame to provide a gasket seal and remove all traces of clay from the Inerteen. (See Fig. 8).

Three GPM Unit. This unit utilizes two tanks, one within the other. The activated clay is held in the inner tank by suitable screens at top and bottom. The space below the inner tank is completely sealed off from the rest of the space between the two tanks. The cover is of double-deck construction, incorporating the top screen for the inner tank and the solid cover for the outer tank. The Inerteen is pumped into the lower space and is forced up through the activated clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through the fine mesh upper screen and out into the space between the two tanks. The discharge pipe is at the lower end of the outside tank and any air in the Inerteen is trapped in the upper space of the outside tank where it may be drawn off.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is, therefore, considered advisable to condition Inerteen from the top and return it to the bottom of the Inerteen filled apparatus.

One charge of clay is composed of approximately 40 pounds of 15-30 mesh activated clay.* This relatively large volume of clay makes only occasional changes of clay necessary, depending of course on the amount and condition of the Inerteen filtered. Normally one charge will condition approximately 3000 gallons of Inerteen. The coarse granulated clay used gives maximum surface contact between clay and liquid and makes possible a rapid and thorough mixing of the clay and Inerteen to accomplish complete reconditioning of the Inerteen as it passes through the clay tank. The clay granules are removed from the Inerteen by means of fine screen in the 3 GPM filter and by screen and paper in the 7 GPM filter.

The clay never passes through the pump to cause wear on pump parts and consequent loss of pumping capacity. As soon as the charge of activated clay is placed in the tank and the cover clamped in place, the unit is ready for immediate use.

Neither clay nor filter paper can be effectively dried of water after they have once become saturated with Inerteen. Therefore, extreme care should be taken to see that both clay and filter paper are thoroughly dried when placed in the filter.

The clay may be dried in a high temperature oven at 200 deg. C. for six hours and shallow pans are preferred as containers for the clay while drying. A paper drying oven may be used if a high temperature oven is not available, with a drying time extended to approximately twenty-four hours at the oven's highest temperature. The filter paper should be dried six to twelve hours at 85°C. to 100°C.,

*Filter paper and activated clay may be obtained from the Westinghouse Sharon Plant.

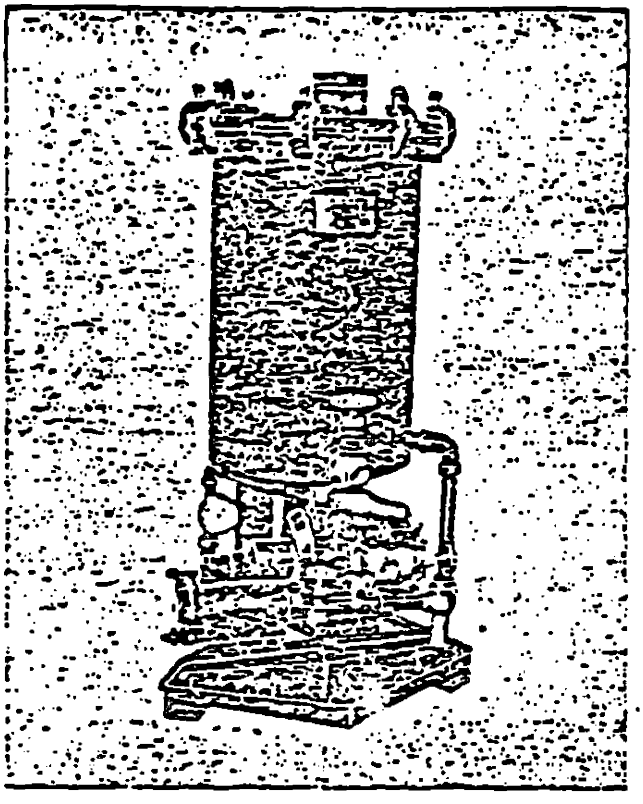


FIG. 5. Three Gallon-per-Minute Conditioner

depending on the condition of the paper and the spacing of the sheets in the oven. Both paper and clay should be placed directly in the filter after the drying process as either, if exposed, will absorb considerable moisture from the atmosphere in a very short time.

Each fresh charge of clay will absorb about three gallons of Inerteen. This should be provided for to prevent depleting the supply in the apparatus, but most of this Inerteen may be recovered when changing clay.

This can be accomplished most effectively by removing the used clay from the filter and placing it in a tank of approximately 30 gallons capacity containing about 5 gallons of water. The tank should have a drain valve at its bottom edge and should be tilted somewhat toward this valve. The clay thus placed in water, having a greater affinity for water, will give up the Inerteen it has absorbed and become saturated with water. The Inerteen being heavier than water will sink to the bottom; the clay and water will float on top. After settling for several hours, most of the Inerteen may be drawn off through the valve. This Inerteen may be reconditioned and used again in recharging the conditioner. The used clay should be discarded.

To Prepare the 7 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the tank with activated clay, 4440-3, to within four inches of the bottom edge of the inner flange. Replace screen and cover. Release the pressure-screw of the filter press and loosen plates and frames. Place one sheet of "S" size blotting paper between the face of each frame and plate. Care should be used to see that the holes thru the plates, frames and paper are in proper alignment before the pressure screw is tightened. Close the discharge, tank by-pass, tank drain, suction and suction-test valves. Open the air discharge valve. Pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons of Inerteen. Start the motor and open the drip pan valve a small amount so that not less than 5 minutes are required to fill the clay tank, saturating the clay with Inerteen. (If Inerteen is admitted too rapidly, it will tend to pack the clay into the top of the tank.) With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge, and drip pan valves.

To begin conditioning Inerteen in Inerteen filled apparatus, open the apparatus valves. Open the conditioner discharge and suction valves. At intervals open air discharge valve to allow trapped air to escape and close when Inerteen starts to flow through valve. Open drip pan valve at intervals too, to remove Inerteen which may have dripped into the drip pan.

When it is necessary to change the clay, first close the valve in the suction line, close the tank

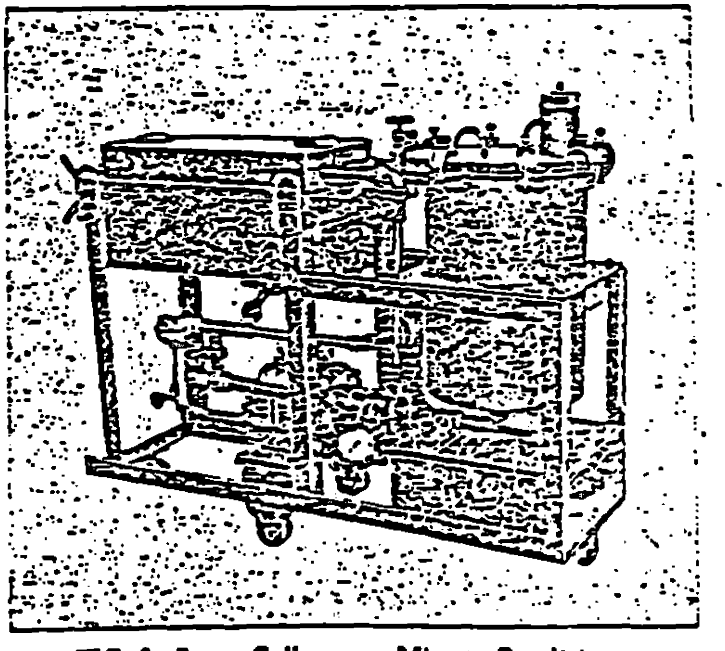


FIG. 6. Seven Gallon-per-Minute Conditioner

inlet and outlet valves, open the tank by-pass valve, the tank drain valve and the air vent valve to permit the free Inerteen in the tank to drain into the lower drip pan. Open the drip pan valve and pump the Inerteen from the drip pan through the filter press. Shut down the motor and remove the clay from the tank and refill with fresh clay as previously described.

To change the filter or blotting papers, stop the motor and close suction and discharge valves. Slowly back off the pressure screw, permitting the Inerteen trapped in the frames to be released gradually. Then back off the pressure screw completely, open up the press and let the surplus Inerteen drain from the papers. Replace the saturated papers with clean dry paper and retighten the press.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to resume conditioning the Inerteen.

To Prepare the 3 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the inner tank with activated clay, 4440-3, to within four inches of the top. Replace screen and cover. Close the discharge and suction valves and open air discharge and drip pan valves about ½ open. Start motor and pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons. Not less than five minutes should be required to fill the clay tank and saturate the clay with Inerteen. With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge and drip pan valves.

To begin conditioning Inerteen, open apparatus valves, open the conditioner discharge and suction valves and start motor.

At intervals open air discharge valve to let trapped air escape and close as soon as Inerteen flows from the valve.

When it is necessary to change the clay, first stop motor and close the valves in the suction and discharge lines. Remove discharge hose and open the discharge valve and tank drain valve to permit the Inerteen in the tank and discharge hose to drain into a container. After draining is complete, remove inner tank and dump the clay from the inner tank and refill with fresh clay as previously described. The used clay should be discarded.

BLOTTER FILTER PRESS

The blotter filter press (See Fig. 7) is essentially a number of sets of blotter filter papers in parallel, each set containing several thicknesses. The Inerteen is pumped through filter paper which absorbs the water and strains out the sediment.

Other Classes of Service. Although there are other uses, such as cleaning of low-viscosisty insulating compounds, benzine, etc., it is recommended that a cleaning device intended for Inerteen reconditioning should not be used for other classes of work, due to danger of subsequent contamination of the Inerteen.

Capacity. The capacity of these machines, with Inerteen pressure and filtering area fixed, depends on the viscosity of the Inerteen and its freedom from dirt. With fairly clean Inerteen at ordinary room temperature, the capacity of the machines will vary from normal to about 15 percent above normal, depending on the viscosity (which varies with the temperature). It has been found that the best results are obtained when the Inerteen temperature is about 50°C. The average working pressure of these machines is less than 40 psi and the pressure relief valve is set at the factory to by-pass the full flow at from 60 psi to 80 psi.

Apparatus. There are three standard sizes of Westinghouse filter presses: B-5, B-10, and A-30. The letter designates the size of filter paper; the number indicates the relative capacity in gallons per minute.

The complete outfit consists of filterpress, motor, strainer, pump, gas trap, pressure gauge, drip pan, wheels, and piping. The piping is arranged so the line can be tested for leaks under pressure. All machines are mounted on a fabricated structural steel frame. The drip pan can be removed by disconnecting one pipe coupling and four bolts. The strainer can be cleaned by disconnecting three bolts. The pumps are of the helical-gear type to insure quietness and smooth flow of Inerteen. The A-30 pump is connected to the motor through flexible couplings. The B-5 and B-10 pumps are mounted directly on the rear motor bracket and driven through a helical reduction gear.

The filter press proper is made up of a series of cast iron plates and frames assembled alternately, with the filter papers between them. By means of a screw and cast-iron end block, the plates, frames, and papers are forced tightly together. Except for a machined rim which serves as a joint to prevent

the escape of Inerteen, the plates are cast with small pyramids on both surfaces.

The plates and frames have holes in two corners and supporting lugs at the sides. The plates have handles cast on the top edge. When the plates and frames are assembled with the filter papers between, the holes form the inlet and outlet. The frames have the holes in the upper corner connected by small ducts to the middle of the frame. The plates have ducts leading from the surface of the plate to the hole in the lower corner. (See Fig. 8).

The Inerteen enters under pressure at the top corner through the inlet formed by the holes in the frames, plates, and filter papers, flows into the frames through the same ducts, and completely fills the chamber formed by the frame and two sets of filter paper. As there are no outlet ducts in the frame, the Inerteen is forced through the paper and flows along the grooves between the rows of pyramids and out through the ducts provided at the lower corner of the plates. The dry filter paper takes up the moisture and removes the sediment from the Inerteen.

Operation. The filter press is made ready for operation by placing a set of five sheets of filter paper (that have been thoroughly dried in an electric oven) between each filter plate and frame. The holes in the filter paper must line up with the holes in the plates and frames. The sediment is strained out by the first layer of paper and the moisture is taken up by the capillary action of the paper.

If any moisture remains, it indicates that the filter papers are saturated with moisture and should be renewed. No rule can be given as to how often the papers must be changed, as this depends entirely on the condition of the Inerteen. The usual procedure is to run the machine for about half an hour (if the Inerteen is not in very bad condition) and then shut down; remove one sheet from the inlet side of each set and put in a new sheet on the outlet side of each set. (The frame is the inlet side and the plate is the outlet side.) Frequent dielectric tests should be made during this procedure as wet Inerteen may necessitate recharging the filter press with a full set of papers before the five sheets have been removed in succession.

The quickest method of filtering a quantity of Inerteen is to pump all the Inerteen through the filter and into another tank which is clean and dry. If care is taken to change the filter papers before they become saturated, the Inerteen will be clean and dry. If a second tank for holding the Inerteen

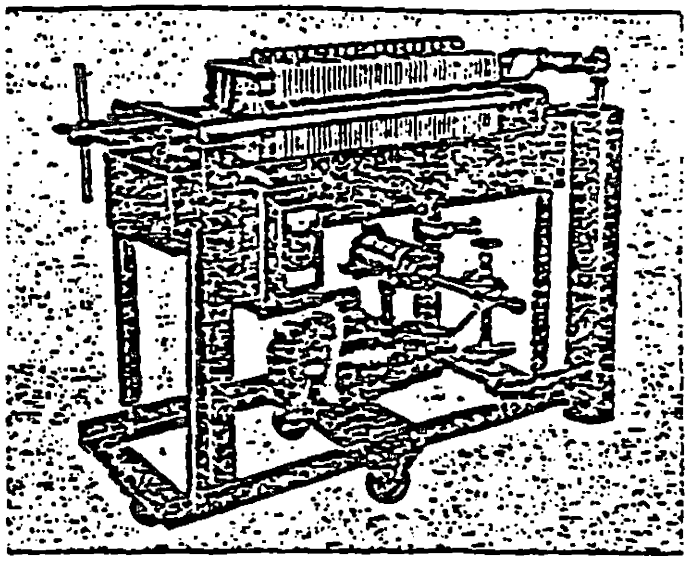


FIG. 7. B-10 Blotter Filter Press

is not available, or if it is desired to filter the Inerteen of apparatus while it is in service, the Inerteen may be pumped from the top of the apparatus tank through the filter and returned to the bottom of the same tank under the surface of the Inerteen. This operation should be continued until the Inerteen in the apparatus tank shows a sufficiently high dielectric strength.

When a large quantity of Inerteen is to be filtered, time may be saved by using two filter presses, one of which may be operated while the other is being recharged.

Filtering through blotter filter papers does not materially reduce organic acidity or improve resistance to emulsification, although the dielectric strength may be restored to a satisfactory value.

The capacity of the filter press is much reduced when operating at low temperatures.

When the Inerteen has to be filtered at low temperatures, an additional pump in the pipe line is desirable.

Inerteen in apparatus contaminated by only a small amount of moisture may be reconditioned by drawing the Inerteen from the top of the apparatus tank, passing it through the filter press, and pumping it back into the bottom of the apparatus. The Inerteen should be put through the system until a sample drawn from the top of the apparatus gives satisfactory dielectric values.

Blotter Filter Paper. The filter paper used is a special grade of blotting paper about .025 in. thick; it contains no coloring matter or chemicals which might injure the Inerteen. Five sheets cut to

the proper size, 12⅞ in. square for the A sizes and 7¾ in. square for the B sizes, and with holes punched to correspond with the holes in the plates and frames, are used between each plate and the adjacent frames.

To obtain the best results in reconditioning Interleen, the paper must be perfectly dry when first placed in the press. Filter paper always takes up moisture if exposed to the air for any length of time and for this reason care must be used in handling. The standard paper is carried in packages containing one ream, carefully wrapped in waxed paper and covered with heavy wrapping paper.

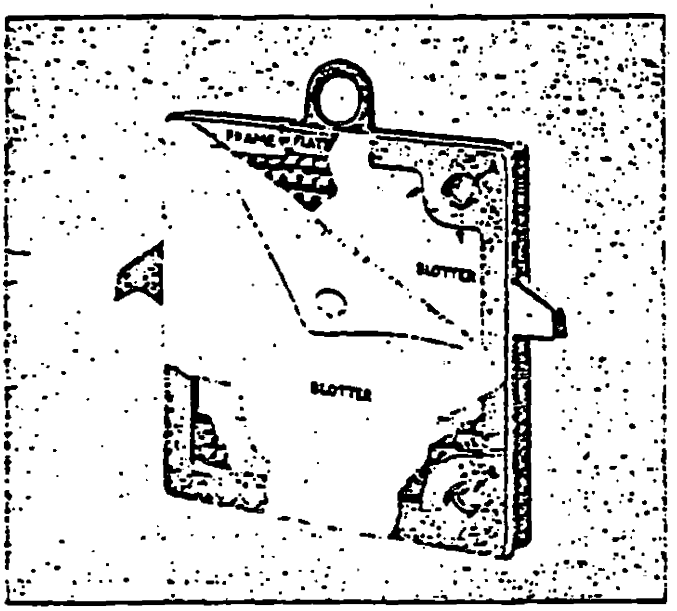


FIG. 8. Blotter Filter Press Frame Showing Blotter Filter Papers in Place

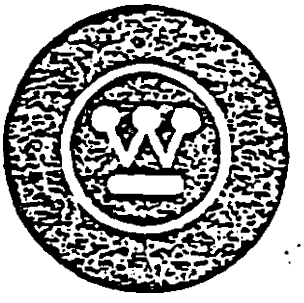
Electric Drying Ovens. Electric drying ovens for use with Type A and Type B filter presses require 2000 watts and 1400 watts respectively. The interior of the ovens is provided with rods for supporting the filter paper to facilitate rapid and thorough drying. An automatic thermostat having a range of 65°C to 120°C is provided for maintaining uniform oven temperature. The thermostat is adjusted at the factory for 100°C, the recommended value, and the setting marked so that the operator may conveniently reset thermostat to 100°C if adjustment is changed.

The standard thermostat-equipped oven is suitable for alternating current only. Ovens to operate on direct current are special and are equipped with a thermometer and a manually operated three-heat switch.

By moving one rod, the Type A oven can be used for drying Type B paper.

The normal capacity of the Type A oven is 240 sheets and the Type B oven is 180 sheets when spaced ¼ inch apart.

Instructions for INERTEEN® Insulating Fluid P.D.S. 54201 CM



500507

Westinghouse Electric Corporation
Power Transformer Division, Sharon, Pa.

Westinghouse Exhibit 7

I.B. 45-063-99A Effective April, 19[illegible]8, Supersedes I.B. 45-063-99, July, 1965

INERTEEN* INSULATING FLUID

P.D.S. 54201CM

Inerteen is a synthetic non-inflammable and non-explosive insulating and cooling liquid. It has proved its suitability for use in all Westinghouse Inerteen insulated apparatus. In order to insure the proper performance of the apparatus, only Westinghouse Inerteen should be used.

This publication gives the instructions for handling, inspection, and maintenance which experience has shown are important in obtaining the best service from the Inerteen.

* Registered trade-mark for Westinghouse Askarel

RECEIVING, HANDLING, STORING

SHIPMENT

Inerteen is shipped in tank cars, drums, or cans. The modern tank cars are usually lagged to prevent rapid fluctuations in temperature during transit and thus reduce the amount of expansion and contraction of Inerteen. Changes in the volume of the Inerteen due to temperature changes tend to cause breathing in of moist air resulting in condensation of moisture inside the container, and lowering of the dielectric strength of the Inerteen.

When shipped in drums, the Inerteen and the drums are both heated above room temperature while the drums are being filled, and the bungs are tightened immediately after filling. After cooling to normal temperature, the bungs are again tightened. The drums are provided with screw bungs having gaskets to prevent admission of water.

When shipped in cans, the cans as well as the Inerteen are heated above room temperature while being filled and are hermetically sealed immediately after filling.

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. If loosened, be sure Inerteen is tested before using, or combining it with good Inerteen.

It is very desirable that Inerteen in drums be stored in a closed room. 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, protection against direct contact of rain and snow should be provided. Drums stored outdoors should be placed so that bungs will be protected from moisture. It is desirable to cover the drums with a tarpaulin.

Cans. Cans containing Inerteen must not be exposed to the weather. Seals should be kept intact until the Inerteen is actually needed.

Screw caps are provided on the cans to use when the Inerteen is only partially removed after hermetic seal has been broken. By replacing the screw caps, contamination by moisture and dirt will be retarded, but the Inerteen must be tested just before using.

Storage Tank. The storage tank should be mounted on piers so that it will not touch the ground, and will be accessible to all points for inspection for leakage.

It is desirable to maintain the temperature of the Inerteen and tank a little above the temperature of the surrounding air as this prevents condensation of moisture in the tank which would affect the dielectric strength of the Inerteen.

The tank should preferably have a convex bottom, allowing for the installation of a drain cock at the lowest point for removing dirt or tank scale which might settle out. As Inerteen is heavier than water, most all of any water present will, in time rise to the top of the Inerteen. A valve somewhere near the normal top level of the Inerteen should be provided for drawing off water-contaminated Inerteen. Provision for drawing off the Inerteen should also be made near the bottom of the tank.

HANDLING

Caution: Inerteen is a skin irritant. Unnecessary contact with the liquid or its vapor, particularly when it is hot, should be avoided. Especially the eyes, nose, and lips are effected when Inerteen comes in contact with them. Certain safety precautions must be observed when handling Inerteen.

In case Inerteen comes in contact with the skin the parts affected should be thoroughly washed in soapy water and followed by an application of cold cream. A supply of these materials should be kept available at all times where persons are working with Inerteen. Continued exposure may cause eruptions on certain individuals due to the absorption of Inerteen through the pores

of the skin. Cleanliness among workmen handling Inerteen is a very good safeguard against such effects. Application of castor oil is recommended for the eyes, castor oil or cold cream for the nose and lips.

Hot apparatus should not be opened except in well-ventilated places. Large quantities of Inerteen should be handled in a closed system. Workmen should be protected from frequent contact with any appreciable vapor concentration and from frequent skin contact with Inerteen.

In case Inerteen is spilled on one's clothing, the clothing should be changed as soon as possible and the soiled clothing laundered before it is worn again. Gloves such as Westinghouse S#1309 974 should be worn when it is necessary to put one's hand into Inerteen or when parts of apparatus must be handled wet.

Mineral oil is completely miscible with Inerteen and it is practically impossible to separate them. Therefore, it is important to avoid contaminating Inerteen with any kind of oil, since its presence changes the non-inflammable and non-explosive characteristics of Inerteen.

Note: The Inerteen should be sampled and tested before being transferred from the container to the apparatus, particularly in cases where the wire lock-seal has been broken. In cases where the apparatus is received with the Inerteen installed, the Inerteen should be sampled and tested before the apparatus is put into service, as described later in this book.

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

Although the drums and tank cars are thoroughly washed and dried at the refinery before filling, a certain amount of scale is sometimes loosened from the inside in transit. Therefore, Inerteen which has not been filtered should be strained through three or more thicknesses of muslin, or other closely woven cotton cloth which has been thoroughly washed and dried to remove the sizing. The straining cloths may be stretched across a funnel of large size and should be renewed at frequent intervals.

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.

Important: Always use all-metal hose or pipe when handling the Inerteen. A hose made of natural rubber should not be used. Inerteen can easily become contaminated from the sulphur in the natural rubber, and should not be allowed to come in contact with it.

When it is necessary to transfer Inerteen from warm surroundings to apparatus exposed to extremely cold weather, even when the dielectric strength at room temperature is high, it is desirable to circulate the Inerteen through an Inerteen conditioner at room temperature. A similar procedure is also advisable in the case of apparatus erected inside and later exposed to cold weather, the reason being that Inerteen will absorb more water at higher temperatures which will be thrown out of solution at lower temperatures. The remainder will be in suspension in the Inerteen and will lower the dielectric strength.

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.

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 benzine, 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.

Caution: Do not use a steel pipe because of the danger of a spark igniting the gasoline or benzine vapor.

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 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.

Refilling Drums. 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.

If it is necessary to refill them for storage, drums which have been used only for clean, dry Inerteen should be reserved for this purpose. They should be closed immediately after being emptied, to exclude dirt and water. After refilling, they should be examined to see that they do not leak.

Whenever a drum is to be filled with Inerteen, the temperature of the drum and of the Inerteen should be at least 5.5°C. (10°F.) higher than the air, but the temperature of the drum need not be the same as that of the Inerteen.

A new washer should be used with the bung each time the drum is refilled, to insure a tight seal. These washers may be obtained from the nearest Westinghouse Office and it is recommended that a supply be kept on hand. Natural rubber composition washers should never be used as they would be attacked by the Inerteen.

Drums to be refilled with Inerteen for storage should be plainly marked with paint for identification.

SAMPLING AND INSPECTION

A good fireproof insulating liquid is one that will act as an insulating liquid, will carry the heat away from the apparatus, and is fireproof. Westinghouse Inerteen meets these requirements with the following characteristics:

1. High dielectric strength.
2. Freedom from inorganic acid, alkali, and corrosive sulphur. (To prevent injury to insulation and conductors)
3. Low viscosity. (To provide good heat transfer)
4. Low pour point.
5. Fireproof.

CAUSES OF DETERIORATION

The principal causes of deterioration of Inerteen are:

1. Presence of water.
2. Arcing.

Condensation from moist air due to breathing of the apparatus, especially when the apparatus is not continuously in service, may injure the Inerteen. (The moist air drawn into the apparatus condenses moisture on the surface of the Inerteen and inside of the tank.) The Inerteen may also be contaminated with water through leakage such as from leaky cooling coils or covers.

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. See Reconditioning, Page 7, for the method of purification.

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 carelessness in handling.

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 naptha, 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 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. 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.

PERIODIC 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 22 kv, it should be conditioned. If facilities are not available for testing Inerteen, see "Westinghouse Inerteen Testing Service" below, and also P.L. 44-860. 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.

INERTEEN 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.# 1608 629, 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, Pa. 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 methods described under "Testing Methods," which follows and is part of this Instruction Book. 500512

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.)

CHARACTERISTICS AND RECONDITIONING

CHARACTERISTICS

Inerteen is chemically stable. It is straw-yellow in color. It 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.

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 caution note under Receiving, Storing, and Handling. (See Page 3.) It should be remembered that mineral oil is completely miscible with Inerteen; in fact, it is practically 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 x 10^9 ohms/cm^3 (212°F (100°C) at 500 volts d-c)
8. Power factor:
   At 60 cycles, 27°F (25°C) 2%
   At 60 cycles, 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 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 gal.
16. Viscosity:
    At 100°F (37.8°C), 82-92 seconds
17. Moisture (Maximum) 35 ppm

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 (both of which will be explained later in this book under "Apparatus for Reconditioning") 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.

TESTING METHODS

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

DIELECTRIC STRENGTH TEST

Apparatus. The testing transformer and the source of supply of energy shall not be less than ½ kva, and the frequency shall not exceed 100 cycles 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 gasoline, 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 1¼ in. below the top of the cup. (A suitable test cup is shown in Fig. 1, and portable testing outfits in Figs. 2, 3 and 4.)

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 gasoline or benzine until they are entirely free from fibers.

The test cup shall be filled with dry, test-free gasoline or 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 25 kv, 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 gasoline and the test repeated.

Note: Evaporation of gasoline from the electrodes may chill them sufficiently to cause moisture to condense on their surface. For this reason, after the final rinsing with gasoline, the test cup should be immediately filled with the Inerteen which is being tested, and the test made at once, or the electrodes should be thoroughly dried before using.

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.

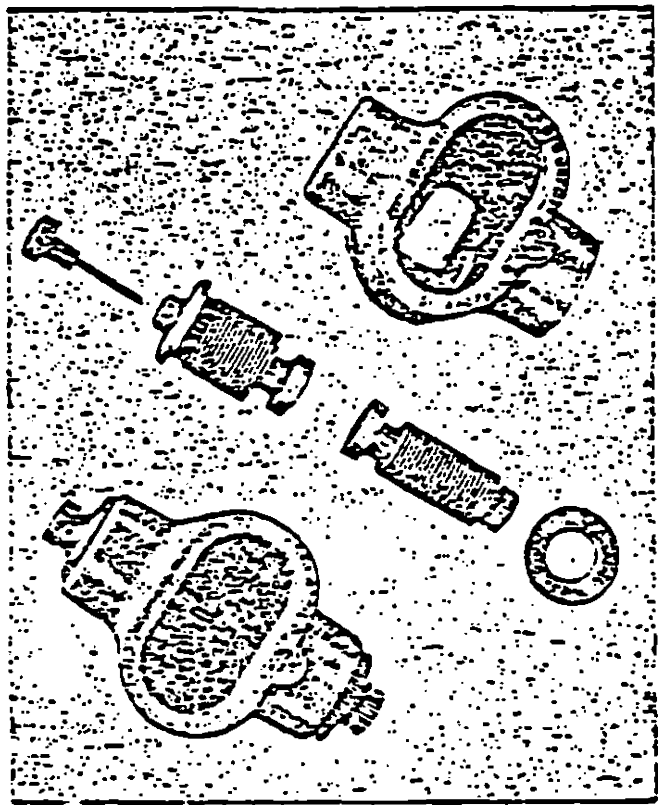


FIG. 1. Fluid Test Cup for Dielectric Test

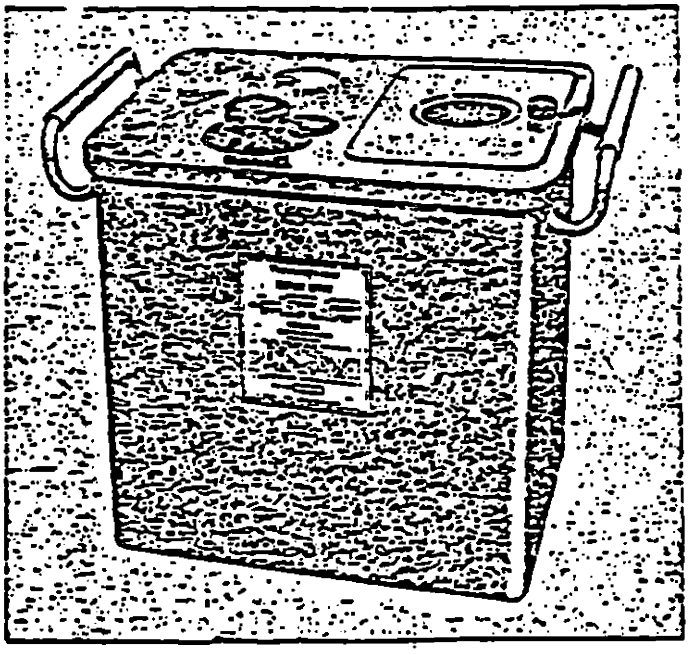


FIG. 2. Portable Oil Testing Set, ½ Kva, 35,000 Volts

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

TESTS

a. Except as specified in (b) 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.

b. 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 (a).

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.

500515

POUR TEST

Note: The procedures covered by the following instructions for the pour test, and especially the neutralization test, require special equip-

nent. The neutralization test must be made by competent chemist, preferably one specializing in this particular field. Customers who do not possess these facilities are offered, at nominal cost, the use of the Westinghouse Inerteen Testing Service. Contact the nearest Westinghouse Office for details.

The pour point of Inerteen is the lowest temperature at which it will pour or flow when it is chilled without disturbance under certain definite specified conditions.

Apparatus. The test jar (see Fig. 4) shall be clear glass, of cylindrical shape, approximately 1¼ in. inside diameter and 4½ to 5 in. high, with a flat bottom. An ordinary 4 oz. Inerteen sample bottle may be used if the test jar is not available.

The cork shall fit the test jar, and shall be bored centrally to accommodate the test thermometer.

The thermometer shall conform to A.S.T.M. specifications for pour test. It may be ordered as: A.S.T.M. thermometer low cloud and pour, —70°F (—56.7°C) to 70°F (+21.1°C).

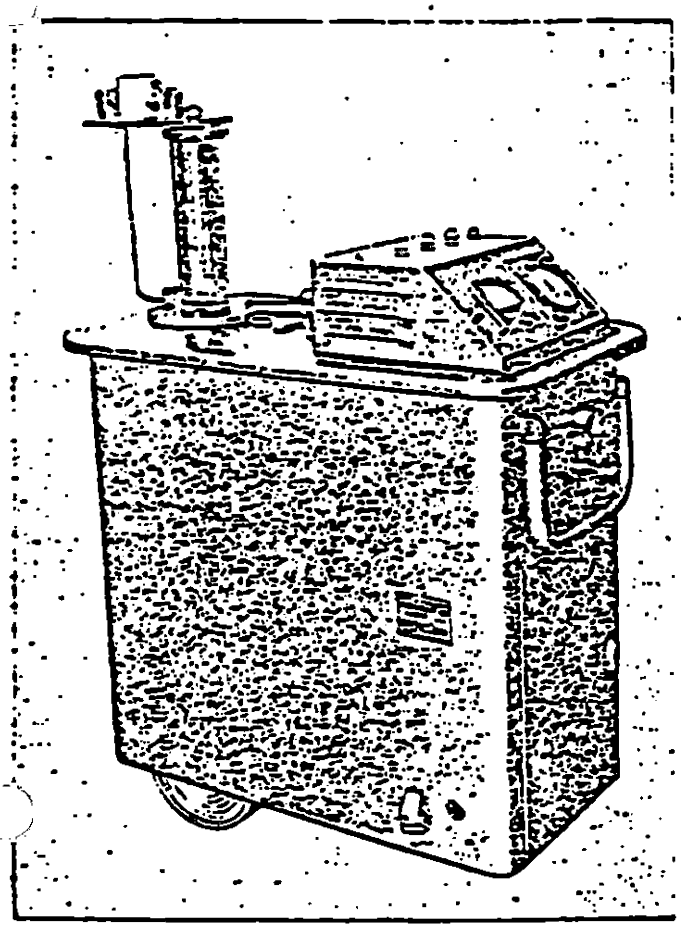


FIG. 3. Portable Trunk Type Insulating Liquid and Insulating Testing Set, 5 Kva, 30,000/60,000 Volts

The jacket shall be of glass or metal and shall be watertight, of cylindrical form, flat bottomed, about 4½ in. deep, with inside diameter ½ in. greater than outside diameter of the test jar.

A disc of cork or felt ¼ in. thick and of the same diameter as the inside of the jacket shall be placed in the bottom of the jacket.

The ring gasket shall be about 3/16 in. thick, made to fit snugly around the outside of the test jar and loosely inside the jacket. This gasket may be made of cork, felt, or other suitable material, elastic enough to cling to the test jar and hard enough to hold its shape. The purpose of the ring gasket is to prevent the test jar from touching the jacket.

The cooling bath shall be of a type suitable for obtaining the required temperature. The size and shape of the bath are optional but a support suitable for holding the jacket firmly in a vertical position is essential. For determination of very low pour points, a smaller insulated cooling bath may be used and the test jar placed directly in it. The required bath temperature may be maintained by refrigeration if available, otherwise by suitable freezing mixtures.

Procedure. The Inerteen to be tested shall be brought to a temperature at least 25°F. (14°C.), above the approximate cloud point. Moisture, if present, shall be removed by any suitable method, as by filtration through dry filter paper until the Inerteen is perfectly clear. (Such filtration shall be made at a temperature at least 25°F. (14°C.), above the approximate cloud point.) The Inerteen shall be poured into the test jar, to a height of not less than 2 in. or more than 2¼ in. When necessary, the Inerteen shall be heated in a water bath just enough so it will pour into the test jar.

The test jar shall be tightly closed by the cork carrying the test thermometer in a vertical position in the center of the jar; the thermometer bulb should be immersed so that the beginning of the capillary shall be ⅛ in. below the surface of the Inerteen.

Heat without stirring to a temperature of 115°F. (46.1°C.) in a bath maintained at not higher than 118°F. (47.8°C.). The Inerteen shall then be cooled to 90°F. (32.2°C.) in air or in a water bath approximately 77 F. (25 C.) in temperature.

The cork or felt disc shall be placed in the bottom of the jacket and the test jar, with the ring gasket, 1 in. above the bottom, shall be inserted into the jacket. The disc, gasket, and inside of jacket shall be clean and dry.

During the cooling of the Inerteen, care shall be taken not to disturb the mass of the Inerteen nor to permit the thermometer to shift in the Inerteen.

The temperature of the cooling bath shall be adjusted so that it is below the pour point—approximately -25.6°F (-32°C)—of the Inerteen by not less than 15°F. (8.3°C) nor more than 30°F. (16.7°C), and the cooling bath shall be maintained at this temperature throughout the test. The jacket containing the test jar shall be supported firmly in a vertical position in the cooling bath so that not more than 1 in. of the jacket projects out of the cooling medium.

Beginning at a temperature 20°F. (11.1°C.) above the expected pour point, at each lower test-thermometer reading which is a multiple of 5°F. (2.8°C). the test jar shall be removed from the jacket carefully and shall be tilted just sufficiently to ascertain whether there is a movement of the Inerteen in the test jar. The complete operation of removal and replacement shall require not more than three seconds. As soon as the Inerteen in the test jar does not flow when the jar is tilted, the test jar shall be held in a horizontal position for exactly five seconds, as noted by a stop watch or other accurate timing device, and observed carefully. If the Inerteen shows any movement under these conditions, the test jar shall be immediately replaced in the jacket and the same procedure repeated at the next temperature reading 5°F. (2.8°C.) below the previous reading.

The test shall be continued in this manner until a point is reached at which the Inerteen in the test jar shows no movement when the test jar is held in a horizontal position for exactly five seconds. The reading of the test thermometer at this temperature, corrected for error if necessary, shall be recorded. The pour point shall be taken as the temperature 5 F. (2.8 C.) above this solid point.

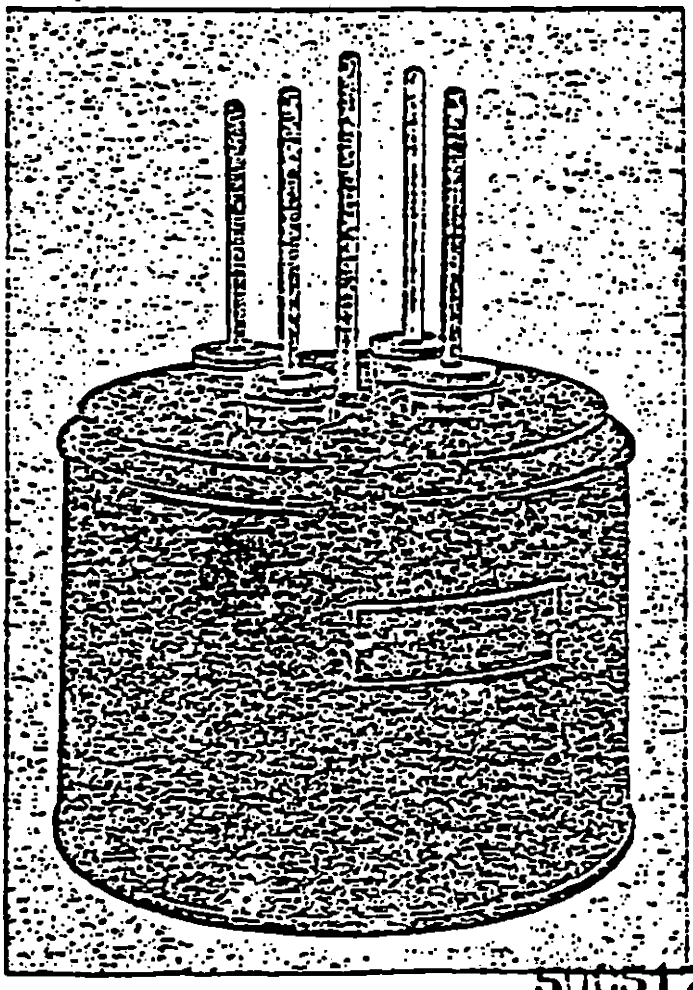


FIG. 4. Apparatus for Pour Test

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, 0.1 N)—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.

c. Alpha-Naphtholbenzein Indicator Solution—Prepare a solution containing 10 g. of alpha-naphtholbenzein per liter 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 KOH per g. of Inerteen = $\frac{(A\text{-}B\ (N) \times 56.1}{W}$

A = ml KOH solution required for sample.
B = ml KOH solution required for blank.
N = normality of KOH solution.
W = grams of sample used.

APPARATUS FOR RECONDITIONING

There are several types of reconditioning apparatus available, the relative advantages of each of which are as follows:

1. The Inerteen Conditioner is the most effective method of removing moisture, dirt, and other contaminating materials from Inerteen.

2. The filter press is suitable for treating Inerteen containing only small quantities of water and dirt.

INERTEEN CONDITIONER

The Inerteen Conditioner consists of a clay container, clay filter, a motor-driven positive pressure pump, attendant valves, gauges, and relief devices, all mounted on a common base.

The motor and pump are combined as a unit and a strainer is provided on input to the pump to prevent entrance of large particles. The units are designed to operate under working pressures up to 60 psi. However, the usual operating pressure is 30 psi to 40 psi. Excessive pressures are prevented by two automatic by-pass valves. One by-pass valve connected across the pump is set to by-pass the Inerteen at a pressure of 60 psi to 70 psi. The other by-pass valve is connected on the discharge side of the conditioner. This latter by-pass valve, releasing at a pressure of approximately 5 psi, will avoid breaking the transformer relief diaphragm when no other relief is provided. Pump pressures are indicated by a pressure gauge.

Seven GPM Unit. The activated clay is contained in a tank mounted on one end of the filter frame. This tank is provided with a cover which incorporates an air-trap and vent to remove air which might be present in the tank and piping. The Inerteen is pumped up through the clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through a wire screen prior to entering the paper filter to remove practically all of the clay. The paper filter consists of 18 frames and 17 plates, alternately spaced, mounted in a yoke. One sheet of filter paper is used between each plate and frame to provide a gasket seal and remove all traces of clay from the Inerteen. (See Fig. 8).

Three GPM Unit. This unit utilizes two tanks, one within the other. The activated clay is held in the inner tank by suitable screens at top and bottom. The space below the inner tank is completely sealed off from the rest of the space between the two tanks. The cover is of double-deck construction, incorporating the top screen for the inner tank and the solid cover for the outer tank. The Inerteen is pumped into the lower space and is forced up through the activated clay, insuring thorough agitation of the clay and Inerteen. The Inerteen is passed through the fine mesh upper screen and out into the space between the two tanks. The discharge pipe is at the lower end of the outside tank and any air in the Inerteen is trapped in the upper space of the outside tank where it may be drawn off.

Since the density of Inerteen is considerably greater than that of water, moisture will float on the surface of the Inerteen. It is, therefore, considered advisable to condition Inerteen from the top and return it to the bottom of the Inerteen filled apparatus.

One charge of clay is composed of approximately 40 pounds of 15-30 mesh activated clay.* This relatively large volume of clay makes only occasional changes of clay necessary, depending of course on the amount and condition of the Inerteen filtered. Normally one charge will condition approximately 3000 gallons of Inerteen. The coarse granulated clay used gives maximum surface contact between clay and liquid and makes possible a rapid and thorough mixing of the clay and Inerteen to accomplish complete reconditioning of the Inerteen as it passes through the clay tank. The clay granules are removed from the Inerteen by means of fine screen in the 3 GPM filter and by screen and paper in the 7 GPM filter.

The clay never passes through the pump to cause wear on pump parts and consequent loss of pumping capacity. As soon as the charge of activated clay is placed in the tank and the cover clamped in place, the unit is ready for immediate use.

Neither clay nor filter paper can be effectively dried of water after they have once become saturated with Inerteen. Therefore, extreme care should be taken to see that both clay and filter paper are thoroughly dried when placed in the filter.

The clay may be dried in a high temperature oven at 200 deg. C. for six hours and shallow pans are preferred as containers for the clay while drying. A paper drying oven may be used if a high temperature oven is not available, with a drying time extended to approximately twenty-four hours at the oven's highest temperature. The filter paper should be dried six to twelve hours at 85°C. to 100°C.,

*Filter paper and activated clay may be obtained from the Westinghouse Sharon Plant.

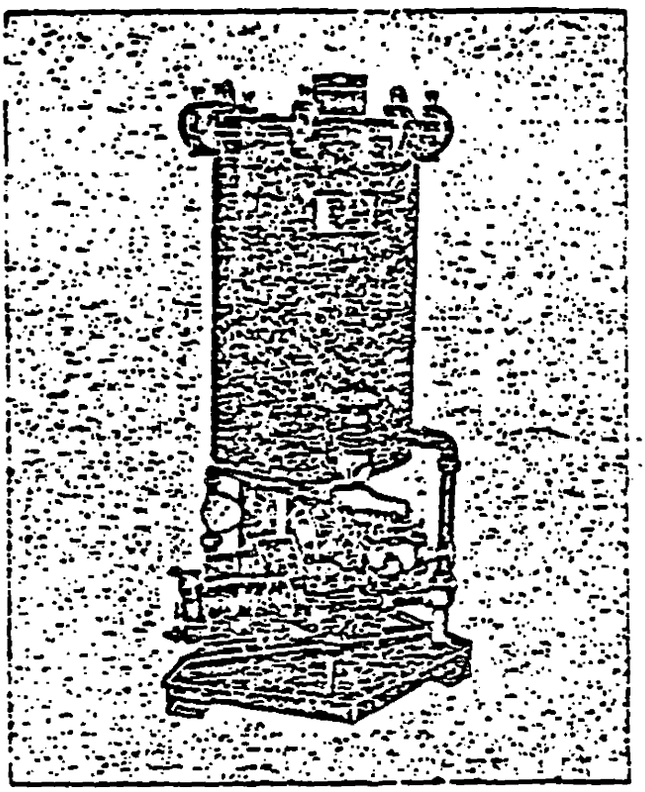


FIG. 5. Three Gallon-per-Minute Conditioner

depending on the condition of the paper and the spacing of the sheets in the oven. Both paper and clay should be placed directly in the filter after the drying process as either, if exposed, will absorb considerable moisture from the atmosphere in a very short time.

Each fresh charge of clay will absorb about three gallons of Inerteen. This should be provided for to prevent depleting the supply in the apparatus, but most of this Inerteen may be recovered when changing clay.

This can be accomplished most effectively by removing the used clay from the filter and placing it in a tank of approximately 30 gallons capacity containing about 5 gallons of water. The tank should have a drain valve at its bottom edge and should be tilted somewhat toward this valve. The clay thus placed in water, having a greater affinity for water, will give up the Inerteen it has absorbed and become saturated with water. The Inerteen being heavier than water will sink to the bottom; the clay and water will float on top. After settling for several hours, most of the Inerteen may be drawn off through the valve. This Inerteen may be reconditioned and used again in recharging the conditioner. The used clay should be discarded.

To Prepare the 7 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the tank with activated clay, 4440-3, to within four inches of the bottom edge of the inner flange. Replace screen and cover. Release the pressure-screw of the filter press and loosen plates and frames. Place one sheet of "B" size blotting paper between the face of each frame and plate. Care should be used to see that the holes thru the plates, frames and paper are in proper alignment before the pressure screw is tightened. Close the discharge, tank by-pass, tank drain, suction and suction-test valves. Open the air discharge valve. Pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons of Inerteen. Start the motor and open the drip pan valve a small amount so that not less than 5 minutes are required to fill the clay tank, saturating the clay with Inerteen. (If Inerteen is admitted too rapidly, it will tend to pack the clay into the top of the tank.) With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge, and drip pan valves.

To begin conditioning Inerteen in Inerteen filled apparatus, open the apparatus valves. Open the conditioner discharge and suction valves. At intervals open air discharge valve to allow trapped air to escape and close when Inerteen starts to flow through valve. Open drip pan valve at intervals too, to remove Inerteen which may have dripped into the drip pan.

When it is necessary to change the clay, first close the valve in the suction line, close the tank

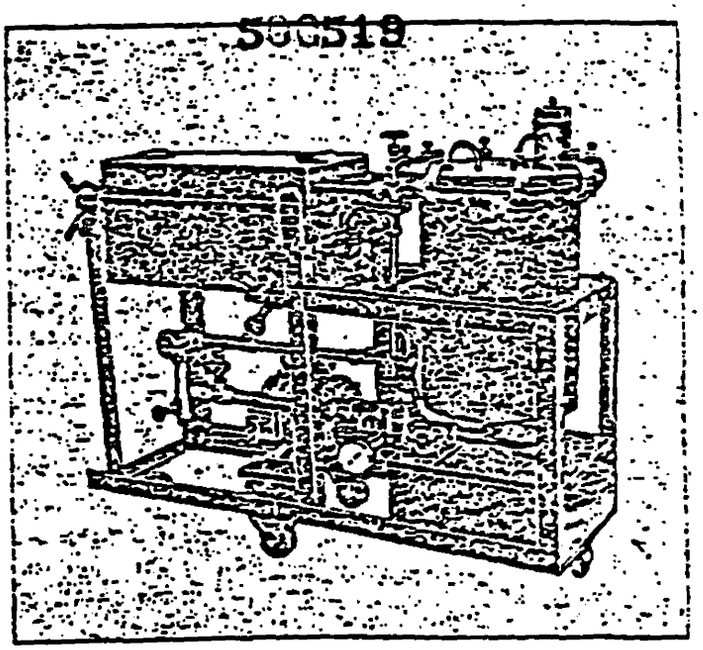


FIG. 6. Seven Gallon-per-Minute Conditioner

let and outlet valves, open the tank by-pass valve, tank drain valve and the air vent valve to permit the free Inerteen in the tank to drain into the lower drip pan. Open the drip pan valve and pump the Inerteen from the drip pan through the filter press. Shut down the motor and remove the clay from the tank and refill with fresh clay as previously described.

To change the filter or blotting papers, stop the motor and close suction and discharge valves. Slowly back off the pressure screw, permitting the Inerteen trapped in the frames to be released gradually. Then back off the pressure screw completely, open up the press and let the surplus Inerteen drain from the papers. Replace the saturated papers with clean dry paper and retighten the press.

If the system-seal is not broken, it will only be necessary to open the discharge and suction valves and start the motor to resume conditioning the Inerteen.

To Prepare the 3 GPM Conditioner for Operation. Remove the cover and screen from the clay tank and fill the inner tank with activated clay, 40-3, to within four inches of the top. Replace screen and cover. Close the discharge and suction valves and open air discharge and drip pan valves about ⅓ open. Start motor and pour sufficient Inerteen into the drip pan to fill the clay tank and wet the clay. This will require approximately eight gallons. Not less than five minutes should be required to fill the clay tank and saturate the clay with Inerteen. With the valve at the apparatus closed, open the suction-test valve to subject the suction line to pressure and thus check it for leaks. Stop motor and close suction-test, air discharge and drip pan valves.

To begin conditioning Inerteen, open apparatus valves, open the conditioner discharge and suction valves and start motor.

At intervals open air discharge valve to let trapped air escape and close as soon as Inerteen flows from the valve.

When it is necessary to change the clay, first stop motor and close the valves in the suction and discharge lines. Remove discharge hose and open discharge valve and tank drain valve to permit Inerteen in the tank and discharge hose to drain into a container. After draining is complete, remove inner tank and dump the clay from the inner tank and refill with fresh clay as previously described. The used clay should be discarded.

BLOTTER FILTER PRESS

The blotter filter press (See Fig. 7) is essentially a number of sets of blotter filter papers in parallel, each set containing several thicknesses. The Inerteen is pumped through filter paper which absorbs the water and strains out the sediment.

Other Classes of Service. Although there are other uses, such as cleaning of low-viscosity insulating compounds, benzine, etc., it is recommended that a cleaning device intended for Inerteen reconditioning should not be used for other classes of work, due to danger of subsequent contamination of the Inerteen.

Capacity. The capacity of these machines, with Inerteen pressure and filtering area fixed, depends on the viscosity of the Inerteen and its freedom from dirt. With fairly clean Inerteen at ordinary room temperature, the capacity of the machines will vary from normal to about 15 percent above normal, depending on the viscosity (which varies with the temperature). It has been found that the best results are obtained when the Inerteen temperature is about 50°C. The average working pressure of these machines is less than 40 psi and the pressure relief valve is set at the factory to by-pass the full flow at from 60 psi to 80 psi.

Apparatus. There are three standard sizes of Westinghouse filter presses: B-5, B-10, and A-30. The letter designates the size of filter paper; the number indicates the relative capacity in gallons per minute.

The complete outfit consists of filterpress, motor, strainer, pump, gas trap, pressure gauge, drip pan, wheels, and piping. The piping is arranged so the line can be tested for leaks under pressure. All machines are mounted on a fabricated structural steel frame. The drip pan can be removed by disconnecting one pipe coupling and four bolts. The strainer can be cleaned by disconnecting three bolts. The pumps are of the helical-gear type to insure quietness and smooth flow of Inerteen. The A-30 pump is connected to the motor through flexible couplings. The B-5 and B-10 pumps are mounted directly on the rear motor bracket and driven through a helical reduction gear.

The filter press proper is made up of a series of cast iron plates and frames assembled alternately, with the filter papers between them. By means of a screw and cast-iron end block, the plates, frames, and papers are forced tightly together. Except for a machined rim which serves as a joint to prevent

the escape of Inerteen, the plates are cast with small pyramids on both surfaces.

The plates and frames have holes in two corners and supporting lugs at the sides. The plates have handles cast on the top edge. When the plates and frames are assembled with the filter papers between, the holes form the inlet and outlet. The frames have the holes in the upper corner connected by small ducts to the middle of the frame. The plates have ducts leading from the surface of the plate to the hole in the lower corner. (See Fig. 8).

The Inerteen enters under pressure at the top corner through the inlet formed by the holes in the frames, plates, and filter papers, flows into the frames through the same ducts, and completely fills the chamber formed by the frame and two sets of filter paper. As there are no outlet ducts in the frame, the Inerteen is forced through the paper and flows along the grooves between the rows of pyramids and out through the ducts provided at the lower corner of the plates. The dry filter paper takes up the moisture and removes the sediment from the Inerteen.

Operation. The filter press is made ready for operation by placing a set of five sheets of filter paper (that have been thoroughly dried in an electric oven) between each filter plate and frame. The holes in the filter paper must line up with the holes in the plates and frames. The sediment is strained out by the first layer of paper and the moisture is taken up by the capillary action of the paper.

If any moisture remains, it indicates that the filter papers are saturated with moisture and should be renewed. No rule can be given as to how often the papers must be changed, as this depends entirely on the condition of the Inerteen. The usual procedure is to run the machine for about half an hour (if the Inerteen is not in very bad condition) and then shut down; remove one sheet from the inlet side of each set and put in a new sheet on the outlet side of each set. (The frame is the inlet side and the plate is the outlet side.) Frequent dielectric tests should be made during this procedure as wet Inerteen may necessitate recharging the filter press with a full set of papers before the five sheets have been removed in succession.

The quickest method of filtering a quantity of Inerteen is to pump all the Inerteen through the filter and into another tank which is clean and dry. If care is taken to change the filter papers before they become saturated, the Inerteen will be clean and dry. If a second tank for holding the Inerteen

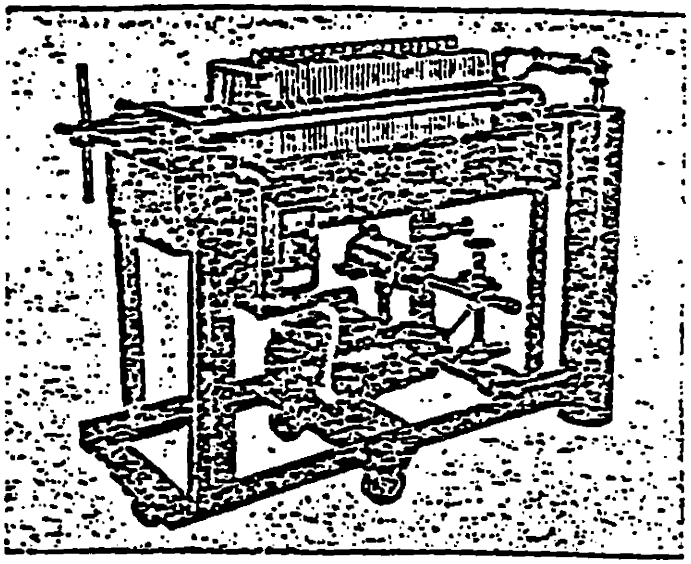


FIG. 7. B-10 Blotter Filter Press

is not available, or if it is desired to filter the Inerteen of apparatus while it is in service, the Inerteen may be pumped from the top of the apparatus tank through the filter and returned to the bottom of the same tank under the surface of the Inerteen. This operation should be continued until the Inerteen in the apparatus tank shows a sufficiently high dielectric strength.

When a large quantity of Inerteen is to be filtered, time may be saved by using two filter presses, one of which may be operated while the other is being recharged.

Filtering through blotter filter papers does not materially reduce organic acidity or improve resistance to emulsification, although the dielectric strength may be restored to a satisfactory value.

The capacity of the filter press is much reduced when operating at low temperatures.

When the Inerteen has to be filtered at low temperatures, an additional pump in the pipe line is desirable.

Inerteen in apparatus contaminated by only a small amount of moisture may be reconditioned by drawing the Inerteen from the top of the apparatus tank, passing it through the filter press, and pumping it back into the bottom of the apparatus. The Inerteen should be put through the system until a sample drawn from the top of the apparatus gives satisfactory dielectric values.

Blotter Filter Paper. The filter paper used is a special grade of blotting paper about .025 in. thick; it contains no coloring matter or chemicals which might injure the Inerteen. Five sheets cut to

the proper size, 12⅞ in. square for the A sizes and 7¾ in. square for the B sizes, and with holes punched to correspond with the holes in the plates and frames, are used between each plate and the adjacent frames.

To obtain the best results in reconditioning Interteen, the paper must be perfectly dry when first placed in the press. Filter paper always takes up moisture if exposed to the air for any length of time and for this reason care must be used in handling. The standard paper is carried in packages containing one ream, carefully wrapped in waxed paper and covered with heavy wrapping paper.

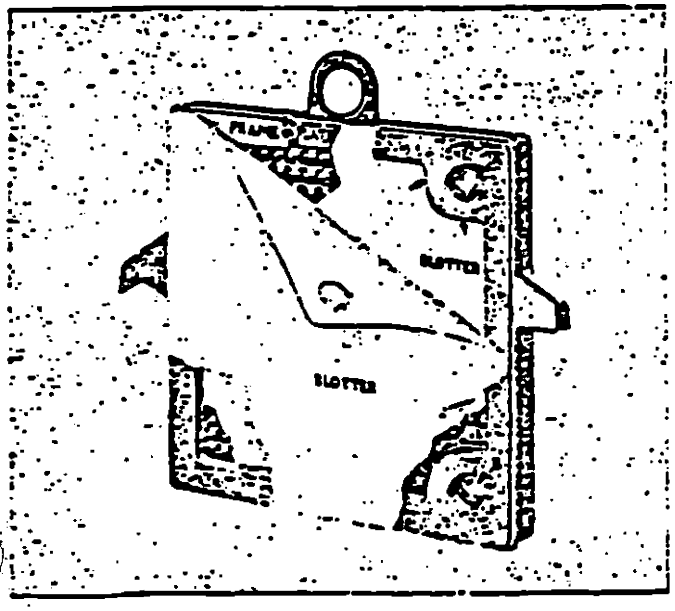


FIG. 8. Blotter Filter Press Frame Showing Blotter Filter Papers in Place

Electric Drying Ovens. Electric drying ovens for use with Type A and Type B filter presses require 2000 watts and 1400 watts respectively. The interior of the ovens is provided with rods for supporting the filter paper to facilitate rapid and thorough drying. An automatic thermostat having a range of 65°C to 120°C is provided for maintaining uniform oven temperature. The thermostat is adjusted at the factory for 100°C, the recommended value, and the setting marked so that the operator may conveniently reset thermostat to 100°C if adjustment is changed.

The standard thermostat-equipped oven is suitable for alternating current only. Ovens to operate on direct current are special and are equipped with a thermometer and a manually operated three-heat switch.

By moving one rod, the Type A oven can be used for drying Type B paper.

The normal capacity of the Type A oven is 240 sheets and the Type B oven is 180 sheets when spaced ¼ inch apart.

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.

I. B. 45-063-99B Effective September, 1968

Supersedes I.B. 45-063-99A April 1968, I.L. 48-650-2 August 1951, I.L. 48-650-3 May 1951, I.L. 48-650-4 May 1951, I.L. 48-650-5B September 1962, I.L. 48-650-6 May 1951, I.L. 48-650-7 June 1951 and I.L. 47-069-6 January 1965.

Contents

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 x 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 absorption of Inerteen through the pores of the skin. Heat apparatus should not be opened except in a well-ventilated area. Large quantities of Inerteen should be handled in a closed system. If 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 steam. If Inerteen gets into the eyes, flush with water and get eye first aid from a physician. Boric 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 heated 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 water 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.

O-RING

[illegible]

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

make 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 transformer; 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 installation 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 connection 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 devices, 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.

Westinghouse Electric Corporation
Power Transformer Division, Sharon, Pa.

Printed in U.S.A. (W.P.D.)

Inerteen® and Environmental Contamination

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 biphenyl (PCB's) are relatively insoluble in water but soluble in fat, and are extremely persistent in the environment. It has been indicated by several laboratories that measurable amounts of the PCB's are present in our general environment and may have some effect on certain species of wildlife. While askarels are generally regarded as being nontoxic to humans, it is reasonable to assume that very high standards of control will be issued by the Government in the overall program against pollution. Therefore, tight control on the usage and disposal of Inerteen must be exercised.

770

While the electrical users of askarel type fluids provide sealed systems, there still remains a problem of waste disposal when the equipment exceeds its useful life or undergoes repair.

For scrap Inerteen fluid, Monsanto has arranged for return of this material in sealed drums. Ship prepaid to

Monsanto Company
W. G. Krummrich Plant
Sauget, Illinois

Attn: Supervisor Dept. 246

A charge will be made for all returned Inerteen.

Inerteen soaked coils, insulation scrap, filter cartridges, and other materials must be stored until appropriate methods can be provided to dispose of them properly.

There is considerable work being done at the present time on this whole problem. We will continue the use of Inerteen because of its outstanding performance record and safety features. If modification of the present askarels can be made without sacrificing the nonflammable and other insulating properties, but which still make them less harmful to wildlife, they will be used in our Inerteen.

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Westinghouse Electric Corporation
POWER TRANSFORMER DIVISION
SHARON PA. • MUNCIE, IND. • S. BOSTON, VA.

Printed in U.S.A.

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
DISTRIBUTION TRANSFORMER DIVISION, SOUTH BOSTON, VIRGINIA

I.B. 45-063-99C Effective August, 1971 Supersedes I.B. 45-063-99B, September 1968

CONTENTS

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 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/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.

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, CO_2 and water vapor. An alkaline scrubber is necessary to neutralize the HCl and the final products released to the atmosphere are CO_2 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 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 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 6. 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 benzine 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 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

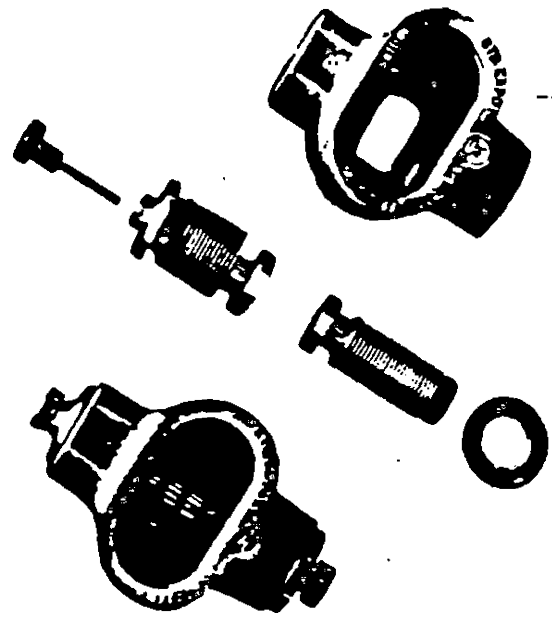

Fig. 1. Fluid Test Cup for Dielectric Test

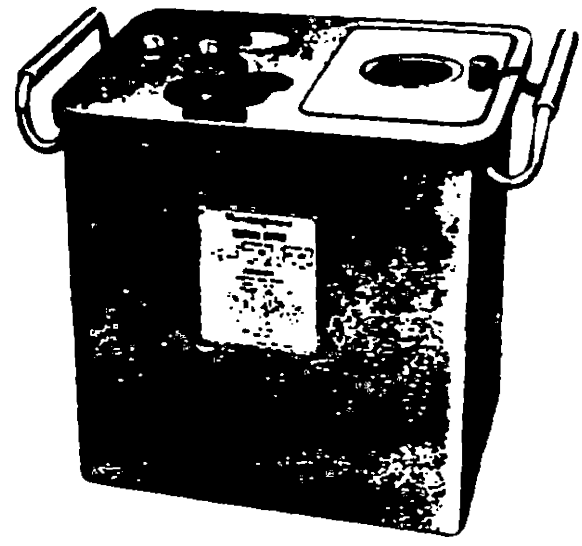

Fig. 2. Portable Oil Testing Set, 1/2 KVA, 35,000 Volts

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. KOH per g. of Inerteen is

$$\frac{(A-B)(N) \times 56.1}{W}$$

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 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 company. Ship prepaid to:

Monsanto Company
W. G. Krummrich Plant
Sauget, Illinois
Attention: Supervisor Dept., 246

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.

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 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.

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.

Memorandum

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Westinghouse

THE LEADER OF THE TRANSFORMER INDUSTRY

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

I.B.-45-063-99D Effective February, 1976 Supersedes I.B. 45-063-99C, August, 1971

CONTENTS

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/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,

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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, CO_2 and water vapor. An alkaline scrubber is necessary to neutralize the HCl and the final products released to the atmosphere are CO_2 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 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 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 benzine 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 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

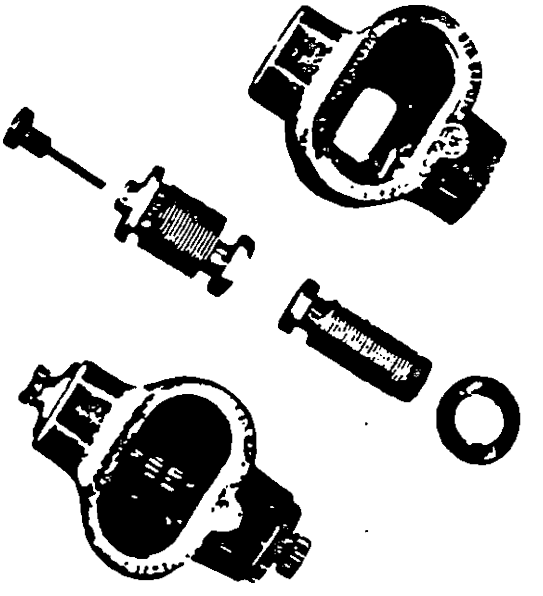

Fig. 1. Fluid Test Cup for Dielectric Test

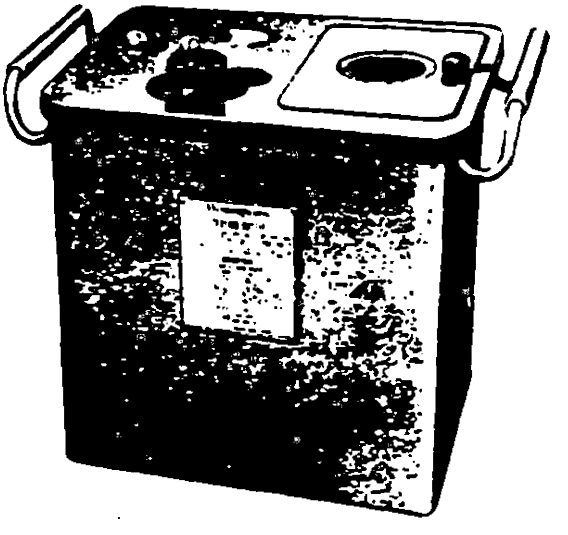

Fig. 2. Portable Oil Testing Set, 1/2 KVA, 35,000 Volts

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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 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	Nuclear Engineering Company Disposal Division Sheffield, Illinois
Chem-Trol Pollution Service, Inc. 4818 Lake Avenue Blasdell, New York 14219	Rollins-Purle, Inc. Box 3349 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

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.

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 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.

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.

Memorandum

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Westinghouse

THE LEADER OF THE TRANSFORMER INDUSTRY

849778

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

I B 45-063-99E Effective June, 1976 Supersedes I.B. 45-063-99D, February, 1976

Westinghouse Exhibit 11

162415

PLAINTIFF'S EXHIBIT 491

CONTENTS

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/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,

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, CO_2 and water vapor. An alkaline scrubber is necessary to neutralize the HCl and the final products released to the atmosphere are CO_2 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 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 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 benzine 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 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

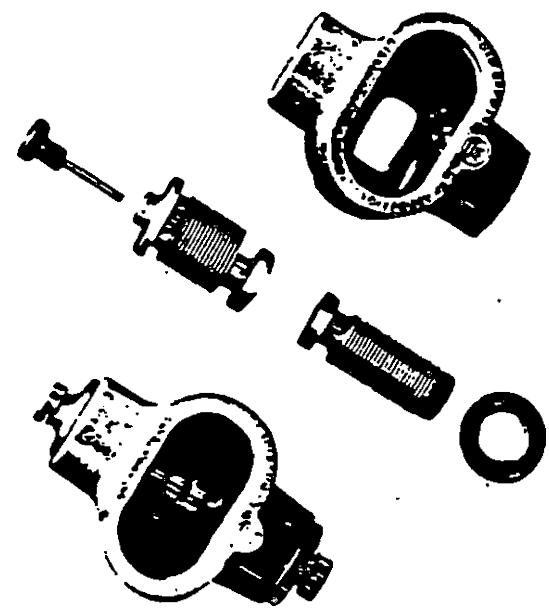

Fig. 1. Fluid Test Cup for Dielectric Test

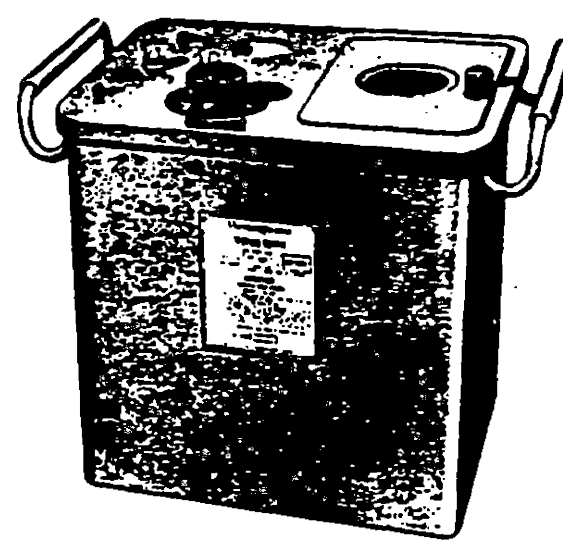

Fig. 2. Portable Oil Testing Set, 1/2 KVA, 35,000 Volts

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 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 Industrial Chemicals Company 800 North Lindbergh Boulevard St. Louis, Missouri 63166	Nuclear Engineering Company Disposal Division Sheffield, Illinois 61361
Chem-Trol Pollution Services, Inc. 1550 Balmer 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. 08014	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.

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 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.

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.

Memorandum

162429

Westinghouse

THE LEADER OF THE TRANSFORMER INDUSTRY

Manufacture by Serial Number

Year	Serials
1916	404 400– 435 299
1917	435 300– 514 457
1918	514 458– 526 174
1919	526 175– 549 169
1920	549 170– 604 799
1921	604 800– 631 893
1922	631 894– 674 000
1923	674 001– 774 799
1924	1040 043–1113 030
1925	1113 031–1222 330
1926	1222 331–1345 312
1927	1345 313–1484 708
1928	1484 709–1572 234
1929	1572 335–1727 703
1930	1727 704–1861 840
1931	1861 841–1931 800
1932	1931 801–1939 000
1933	1939 001–1970 875
1934	2026 231–2062 299
1935	2062 300–2103 800
1936	2103 801–2210 799
1937	2210 800–2363 999
1938	2364 000–2448 000
1939	2448 001–2547 500
1940	2547 501–2664 850
1944	2664 851–3195 000
1[illegible]	3195 001–3324 800
1[illegible]	3324 801–3500 818
1944	3500 819–3659 400
1945	3659 401–3809 130
1946	3809 131–4122 772
1947	4122 773–4740 745
1948	4740 746–5163 189
1949	5163 190–5342 815
1950	5342 816–5809 897
1951	5809 898–6201 899
1952	6201 900–6709 842
1953	6709 843–7153 015
1954	7153 016–7255 585
1955	55A00001 and Up
1956	56A00001 and Up
1957	57A00001 and Up
1958	58A00001 and Up
1959	59A00001 and Up
1960	60A00001 and Up
1961	61A00001 and Up
1962	62A00001 and Up
1963	63A00001 and Up
1964	64A00001 and Up
1965	65A00001 and Up

Year	Serials
1966	66A00001 and Up
1967	67A00001 and Up
1968	68A00001 and Up
1969	69A00001 and Up
1970	70A00001 and Up
1971	71A00001 and Up
1972	7211 - - - - and Up
1973	7311 - - - - and Up
1974	7411 - - - - and Up
1975	7511 - - - - and Up
1976	7611 - - - - and Up
1977	7711 - - - - and Up
1978	7811 - - - - and Up
1979	7911 - - - - and Up
1979	17900001 and Up (Pinetops Production)

Classes of Purchasers

Class	Discount Schedule
User Government: State, county and municipal governments, all Federal Government agencies	44-001
Electric Utility and Industrial Customers Contractors And all unclassified buyers purchasing for their own use.	
Manufacturers ② Electrical equipment manufacturers ② purchasing for resale with or as a part of their product who have Headquarters approval and for whom Form 7119 has been executed.	44-004

① Educational institutions use this schedule
② These manufacturers make and sell equipment for which transformers become component parts, leaving their identity as separate pieces of apparatus.

Westinghouse Electric Corporation
Medium Power Transformer Division
Sharon, PA 16146 USA

Meter and LVIT Division
Raleigh, N.C. 27611 USA

WESTINGHOUSE EXHIBIT 12

Date of Manufacture by Serial Number①

Note that distribution transformers having serial number less than 1,000,000 were built at East Pittsburgh plant. Distribution transformers having serial number 1,000,000 or over were built at the Sharon plant or Sunnyvale, Calif., plant.

Serial Numbers	Year of Manufacture
404400 to 438298	②1916
438300 to 514457	②1917
514458 to 526174	②1918
526175 to 549169	②1919
549170 to 604799	1920
604800 to 631683	1921
631684 to 674000	1922
674001 to 774799	1923
1008740 to 1082622	1924
1082623 to 1234960	1925
1234961 to 1336384	1926
1336385 to 1472121	1927
1472122 to 1591242	1928
②1600000 to 1608230	1928
1591243 to 1781182	1929
②1608231 to 1618757	1929
1781183 to 1874076	1930
1758 to 1818999	1930
1000 to 1748867	
1978 to 1824631	1931
②1748868 to 1756785	1931
1824632 to 1960000	1932
1960001 to 2026230	1933
②1756786 to 1758310	1932
②1756311 to 1758720	1933
2026231 to 2062299	1934
②1758721 to 1758999	1934
②2000001 to 2002400	1934
2062300 to 2103600	1935
②2002401 to 2008828	1935
2013601 to 2228868	1936
②2008829 to 2020000	1936
②2420000 to 2420165	1936
2230000 to 2417299	1937
②2420166 to 2433064	1937
2417300 to 2586000	1938
②2433065 to 2436334	1938
2586001 to 2722500	1939
②2436335 to 2439999	1939
②2660000 to 2665389	
2722501 to 2845700	1940
②2665390 to 2678800	1940
2845701 to 3128800	1941
②2678801 to 2678999	1941
②2960000 to 2970899	
3128801 to 3178100	1942
2978000 to 2979999	1942
②3260000 to 3262569	
3178101 to 3228642	1943
②3262570 to 3268129	1943
3228643 to 3296000	1944
②3268130 to 3278998	1944
②3700000 to 3703359	1944
3296001 to 3320089	1945
3940100 to 3956327	1945
②3703360 to 3719999	1945
②3920100 to 3928750	1945
3956328 to 4140099	1946
4160100 to 4210495	1946
②3928751 to 3940099	1946
②4140100 to 4152117	1946
4210496 to 4576060	1947
②4152118 to 4160099	1947
②4480100 to 4480999	1947
②4480600 to 4482999	1947
②4870000 to 4885999	1947
4576061 to 5097122	1948
②4890000 to 4908988	1948
②5360000 to 5363000	1949
5097123 to 5523854	1949
②5363001 to 5389113	1949
5523855 to 5870889	1950
②5389114 to 5396899	1950
②5440000 to 5468065	1950
5871000 to 6049850	1951
②5456056 to 5468999	1951
②6180000 to 6184279	1951
②6320000 to 6322187	1951
②6322188 to 6349185	1952
6060000 to 6159999	1952
6350000 to 6424834	1952
②6349186 to 6349992	1953
6402993 to 6560388	1953
②6800000 to 6921222	1953
6559000 to 6643849	1954
②6921223 to 6941514	1954
55A1	③1955
55SM10	③1955
65AD10	③1965
76A010001	③1976

Code Identification④

Year	Code Year	55 1955			56 1956			65 1965						
Place of Manufacture	Code Location	Blank Sharon			S Sunnyvale⑤			A Athens						
Month	Code Month	A Jan.	B Feb.	C Mar.	D Apr.	E May	F June	G July	H Aug.	J Sept.	K Oct.	L Nov.	M Dec.	
Week	Code Week	01 Week 1	02 Week 2	.....									52 Week 52	
Manufacturing Serial Number (Maximum of Five Digits)		1 to 99,999												

Examples: 55A1, 55SM10, 65AD10

Year	Location	Month/ Week	Manufacturing Serial Number	Description
55	..	A	1	First Transformer Manufactured at Sharon in January, 1955
56	S	M	10	Tenth Transformer Manufactured at Sunnyvale in December, 1956
65	A	B	10	Tenth Transformer Manufactured at Athens in April, 1965
76	A	01	0001	First Transformer Manufactured at Athens in first week in January, 1976

① Refer to Westinghouse for serial numbers prior to 1916.

② In July 1917, serial numbers on distribution transformers having style numbers were discontinued until June 1919, when they were reinstated. During the period in question, the date of manufacture and L.sec. number were stamped on the nameplate in place of the serial number.

③ Sunnyvale plant.

④ Code identification began late in 1954.

⑤ Distribution transformer manufacturing discontinued in December, 1964.

⑥ Week code rather than month code effective January 1, 1976.

Note: Cast iron tanks were discontinued with serial number about 520000.

...anged or added since previous issue.

Westinghouse Electric Corporation
Distribution Transformer Division
Overhead Distribution Transformer Dept.
Athens, Georgia 30601

Code Identification; Sharon, Athens, Sunnyvale

Serial Numbers	Year of Manufacture
5SA1	①1965
5SM10	①1965
5SAD10	①1965

Year	Code Year	55 1965	56 1966	65 1965
Place of Manufacture	Code Location	Blank Sharon	S Sunnyvale②	A Athens

Month	Code Month	A Jan.	B Feb.	C Mar.	D Apr.	E May	F June	G July	H Aug.	J Sept.	K Oct.	L Nov.	M Dec.
Manufacturing Serial Number (Maximum of Five Digits)		1 to 99,999											

Examples: 5SA1, 56SM10, 65AD10

Year	Location	Month	Manufacturing Serial Number	Description
55	Blank	A	1	First Transformer Manufactured at Sharon in January, 1955
56	S	M	10	Tenth Transformer Manufactured at Sunnyvale in December, 1956
65	A	D	10	Tenth Transformer Manufactured at Athens in April, 1965

Code Identification; Jefferson City

Year	Code Year	72 1972	73 1973

Month	Code Month	A Jan.	B Feb.	C Mar.	D Apr.	E May	F June	G July	H Aug.	J Sept.	K Oct.	L Nov.	M Dec.
Production Date	Code Date	350	355	360									
		Refer to Sales Department, Jefferson City											
Serial Within Production Date		1 to 999											

Example: 72L360001

Year	Month	Production Date	Serial
72	L	360	001

First transformer manufactured at Jefferson City during production week 360 in November, 1972.

① Early identification began late in 1964
② Distribution transformer manufacturing discontinued in December, 1964.

Westinghouse Electric Corporation
Underground Distribution Transformer Division
Jefferson City, Missouri 65101

...ling Policy

...ode Identification; Sharon, Sunnyvale, Athens

...el Numbers	Year of Manufacture
5A1	①1965
5SM10	②1965
5AD10	③1965

...	Code												
	Year	65 1965			65 1965			65 1965					
...ce of ...facture	Code	Blank			S			A					
	Location	Sharon			Sunnyvale②			Athens					
...onth	Code	A	B	C	D	E	F	G	H	J	K	L	M
	Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
...nufacturing Serial ...mber (Maximum of ...n Digits)		1 to 99,999											

...mples: 65A1, 65SM10, 65AD10

...el	Location	Month	Manufacturing Serial Number	Description
	..	A	1	First Transformer Manufactured at Sharon in January, 1965
	S	M	10	Tenth Transformer Manufactured at Sunnyvale in December, 1965
	A	D	10	Tenth Transformer Manufactured at Athens in April, 1965

...de Identification; Jefferson City (Effective 1/1/72 through 12/31/77)

...th	Code												
	Year	72 1972	73 1973										
	Code	A	B	C	D	E	F	G	H	J	K	L	M
	Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
...ufacturing ...e	Code	350	355	360									
	Date	Refer to Sales Department, Jefferson City											
...ial ...ber ...uction ...k		1 to 999											

...ple: 72L360001

...	Month	Production Date	Serial
	L	360	001

...transformer manufactured at Jefferson City ...g production week 360 in November, 1972.

...tive January 1, 1978, all transformers manufactured ...fferson City (including some overheads) will have ...l numbers on the nameplate as follows:

Jefferson City Manufacture	Month	Schedule Date	Sequence No.
J	A	630	001

Some overhead distribution transformers were made in 1976-1977 in Jefferson City. The letter "J" between year and month identifies these units.

Example: 77JA360001

Year	Month	Production Date	Serial
77 J	A	360	001

...de identification began late in 1964.
...tribution transformer manufacturing ...ntinued in December, 1964.
...anged or added since previous issue.

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...house Electric Corporation
...ion Transformer Division
...rground Distribution Transformer Dept.
...son City, Missouri USA 65101