



INSTRUCTIONS

SHIPMENT AND INSTALLATION OF POWER TRANSFORMERS

SHIPMENT

Transformers are shipped in their own tanks in an upright position when shipping clearances and weights permit. Special sectionalizing of the tank, shipment in a horizontal position or special shipping tanks or covers are avoided if possible. Such forms of shipment will have been cleared with the purchaser in advance and are shown on the outline drawing. Any special bracing required, which must be removed by the erectors before installation will also be described on the outline drawings.

Detachable radiators are usually removed and crated for shipment. The radiator valves on the transformer case are fitted with blind flanges and the radiator header openings are sealed with metal covers to keep out dirt and moisture.

Bushings of 69 kv and lower voltages are shipped on the transformers when shipping clearances permit and there is no chance of their being damaged. The crates used for bushings removed for shipment are securely fastened down and are constructed to prevent handling and shipping damage. The bushing openings on the transformer case are sealed with blind flanges.

Lightning arresters, when ordered, are shipped in crates designed to prevent handling and shipping damage. The mounting brackets may be removed from the transformer for shipment.

If shipping clearances permit, most fittings that are rugged enough to stand shipping strains are shipped mounted in place. Those that are removed are crated for shipment.

Outline drawing notes indicate the parts that are to be shipped dismantled. Generally, these fittings are shipped on the same car or vehicle to allow immediate assembly.

When transformers are shipped in oil they are usually shipped in their own tanks, but sometimes when other requirements make it desirable the transformers may be shipped in a special shipping tank.

It is occasionally necessary with large transformers to have a joint in the tank so that the top

section may be removed for shipment. Either the regular cover or a special shipping cover is bolted on the top of the lower section of the tank for shipment. If a special cover is used it is sometimes made with a box-like structure which makes room for terminal boards, etc., which extend above the top of the lower section of the tank. The tank is usually filled until the oil extends up into this box. Care must be taken to lower the oil below the joint before removing this cover.

UNPACKING

The transformer should be examined carefully to ascertain whether it has been damaged in shipment and whether all parts are in place and in good condition.

All detail parts shipped separately should be checked against the bill of material and shortages reported immediately to the nearest Westinghouse Sales Office or the Westinghouse Representative on the installation work.

All bushings and accessories that are shipped separately should be thoroughly protected against moisture until they are installed. Care should be exercised during the installation of these parts to protect the transformer against the possible entry of any moisture.

When a transformer is shipped in its own tank with oil, unpacking is a simple matter. It is ready to be set in place when the crating or bracing is removed.

CHECKING TRANSFORMERS AT TIME OF ARRIVAL

TRANSFORMERS SHIPPED IN NITROGEN
are factory sealed and filled with nitrogen to a pressure slightly in excess of three psi at approximately 25°C. The condition of the transformers at the time of arrival should be determined by the following sequence.

Pressure. A pressure reading should be made as soon after arrival as possible and after the temperature has been fairly constant for several hours. A low pressure gauge (preferably one with a

SHIPMENT AND INSTALLATION OF POWER TRANSFORMERS

vacuum scale) should be attached to an upper filter press valve using caution against loss of gas and intake of air. Absolute pressure (gauge reading + 14.7) varies directly with absolute temperature (temperature reading degrees C + 273.)

Oxygen Content. After the pressure test has been made the oxygen content should be measured using a standard Orsat flue gas analyser or a Fyrite Oxygen Indicator, Westinghouse S#1408196. If the transformer pressure is low, care should be taken to prevent outside air from affecting the reading. Compare the measured oxygen content with values at time of shipment as indicated on the Instruction Card tied to the unit. A slight increase can be expected due to diffusion of trapped air after the factory measurement was made.

Dehydrating Material. After the pressure and oxygen content tests are complete, remove the dehydrating container and moisture indicator from the transformer as indicated on the outline drawing. Replace the manhole or handhole cover on the transformer and weigh the dehydrating material container that was removed. Keep a record of this weight for reference.

The moisture indicator should be checked immediately before it is affected by atmospheric moisture.

Interpretation of Results. No limits of pressure, oxygen content or moisture content can be given for determining whether or not the transformer may be put into service without drying out. It is therefore essential that full advantage be taken of the indications afforded by the measurements outlined above, supplemented when necessary by insulation resistance measurements.

The following combination of results may be taken as indicating that the transformer is in a dry condition:

1. All readings close to those reported on instruction card.
2. Low pressure with low oxygen and low moisture content of the dehydrating material.
3. High pressure, low moisture and high oxygen (not exceeding 5%). If the combination of readings is not reassuring, insulation resistance measurements, with the transformer heated to 60-70°C, should be made to aid in making a decision as to the advisability of drying out the transformer before placing in service.

The transformer will undoubtedly require drying out in the following cases:

1. Obvious damage during transit to the shipping container, resulting in complete loss of pressure and complete diffusion of air into the container.

2. Low pressure, high oxygen, high moisture content.

TEMPORARY STORAGE OF TRANSFORMERS IN NITROGEN

If the transformer is to be stored for a short time do not open the transformers as described above under "Dehydrating Material". This should then be done only when the transformer is installed. Be careful in making the pressure and oxygen content tests to prevent the escape of nitrogen or the entry of air. Transformers should not be stored more than one month in this sealed condition.

The storage of transformers in gas for over one month requires positive assurance that the gas pressure is continuously maintained. The easiest method for accomplishing this is using the Inertiaire equipment. If the transformer is not equipped for Inertiaire temporary pipe connections can be made using the upper filter press or vacuum filling connections. The Engineering and Service Department will obtain the necessary equipment.

The pressure and oxygen content tests should be made and the Inertiaire equipment installed after the transformer is in the storage area. This should be within a few days after delivery of the transformer and in any case not exceeding two weeks. After installing the Inertiaire equipment with a full cylinder of dry nitrogen a complete running log must be kept. Readings of transformer gas pressure and cylinder pressure should be recorded every day for the first month. These readings should preferably be taken at approximately the same time every day and the time also noted on the log. If excessive nitrogen usage is noted during this period the entire unit including the Inertiaire equipment must be inspected for gas leaks with soap suds and the leak corrected. In this case the one month log of readings once a day must be repeated to be sure the gas leak has been corrected.

After the one month of daily logging the pressure readings can be reduced to one every seven days. The oxygen content should be checked once a month. An accurate log is important as it may be the determining factor in any decisions that may have to be made on further drying of the windings. Follow the instructions for the particular Inertiaire equipment used or information provided by the Engineering and Service Department.

Before filling with oil after the transformers have been stored in nitrogen the transformers should be

checked following the procedure under "Checking Transformers At Time of Arrival."

TEMPORARY STORAGE OF TRANSFORMERS IN OIL

Transformers shipped in nitrogen may be stored filled with oil although in many cases this introduces complications that are not desirable.

The storage may be by one of two methods; that is, as received or completely assembled. In either case the following apply.

Determine that the transformer windings are dry as under **INTERPRETATION OF RESULTS**. Vacuum fill the transformer with dry transformer oil. Follow other instructions the same as for placing a transformer in service. If additional assembly is necessary at the time of final installation and the oil must be lowered for this work the unit must be rechecked for dryness and refilled as under vacuum.

LONG-TERM STORAGE OR STANDBY SERVICE OF TRANSFORMERS

The only suitable method for long-term storage, over one year, or idle standby of transformers is to completely assemble, vacuum oil fill and otherwise treat the transformer the same as if it were being placed in service. The maintenance of the units should then be the same as if they were in operation.

LOCATION

Accessibility, ventilation and ease of inspection should be given careful consideration in locating transformers. Indoor transformers must be so located that water cannot fall on the case or rain blow into or upon them.

Self-Cooled Transformers. Self-cooled transformers depend entirely upon the surrounding air for carrying away their heat. For this reason care must be taken to provide adequate ventilating facilities.

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.

For indoor installations the room in which the transformers are placed must be well-ventilated so that hot air can escape readily and be replaced by cool air from 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.

Caution: Care must be taken in handling and installing transformers, particularly those wound for high voltage. Even a very minute amount of moisture in the insulation may cause an insulation breakdown. Every effort should be made to prevent the entrance of moisture. A transformer should not be allowed to stand so that it can absorb moisture from the air or from any other source. A blow upon any part of the winding, stray pieces of solder or wire, tool, nuts, or foreign matter of any kind dropped into the transformer may cause a breakdown or a burnout.

SETTING UP

For convenience of handling, all cases are provided with lifting hooks or eyes, by means of which the case, transformer and oil may be lifted and handled as a unit. Jack lugs are also provided on the base or tank wall for lifting the complete unit. Do not use jacks on any part of the transformer except on lugs provided for this purpose.

Before being set up, a transformer should be inspected for breakage, injury, or displacement of parts during shipment. It should then be tested for dryness and the condition of the oil should be determined as in I.L. 48-620-1.

An outline drawing is furnished showing the relative location of all fittings and this should be followed in setting up. The outline drawing will also list any special features requiring attention during installation.

Important: When working about a transformer particular care must be taken in handling all tools and other loose articles, since material dropped into the windings and allowed to remain may cause a breakdown.

When a transformer has been shipped in its case with oil, it should be inspected for breakage injury or displacement of parts during shipment. This can generally be done without removing any of the oil. A sample of oil should be drawn from the bottom of the case and tested. If the inspection and oil tests are satisfactory, the transformer is ready to be put into service. If the oil tests below 22 kv, it will have to be filtered and it may also be necessary to dry out the transformer. Whether drying will be necessary can be determined by Megger test.

Valve stem packing nuts should be inspected for tightness before transformer is placed in operation.

When going into the case of a shell transformer with the core and coils in place, the tops of the insulating washers offer tempting places on which to

SHIPMENT AND INSTALLATION OF POWER TRANSFORMERS

stand. It is unsafe to stand on these washers but a clean, dry board may be laid across their tops for this purpose.

Caution: Transformers containing nitrogen should be well-ventilated before entering the tank. Anyone entering the tank before it is ventilated may be suffocated due to lack of oxygen. Inside a building or outdoors on a windstill day the only safe procedure is to blow air in the manhole with an electric fan for at least 15 minutes before entering the tank.

Connections. The diagram, usually on a metal plate attached to the side of the case, shows the terminal connections for various voltages. Care should be taken to see that all connections are properly made, as a wrong connection may cause serious damage or burnout. Then with the outlet bushings in place, the high voltage and low voltage leads should be connected to their proper terminals.

In condenser type transformer bushings the lead is sometimes drawn up through the central tube by means of a piece of string or twine and fastened at the top. Be sure that all bushings and terminals are screwed up tightly so they cannot work loose.

Expansion Joints. Where the transformer bushings are to be connected to an external system of piping or external oil or water connections are used, provision must be made for expansion and contraction to prevent excessive stress on bushings or pipe connections and to protect valves, bushings and fittings against strain.

It is recommended that a strainer be placed in oil lines that are connected to transformer tanks to prevent oil line rust or scale from entering the transformer tank.

Thermometer and oil gauge should be attached as shown on the outline drawing.

Cover Bolts. If the cover of a tank with a bolted cover has to be removed the oil should be lowered to the midsection of the tank before trying to remove the bolts. All non-circular vessels distend when subjected to internal pressure and this puts a shearing stress on the bolts making them difficult to remove when the tank is full of oil.

Should occasion arise when alignment of holes will not permit insertion of cover bolts, it is considered best practice to follow the procedure outlined below:

1. Insert all possible bolts.
2. In order to prevent overstressing either angle ring or cover plate, drift pins should be driven into

holes on either sides of bolts in place, inserting bolts as adjoining holes are aligned.

3. Bolts should be drawn up in a consecutive order, making as many circuits of the tank as is required. Pull cover hard against stops which have been provided to prevent overcompression of the gaskets.

Radiators or Coolers. Radiators or any of the various types of coolers shipped as detail items with transformers to be assembled at the final location must be thoroughly inspected prior to assembly to be certain that no water or foreign material is in the oil space. If the equipment is opened when it is at a lower temperature than the ambient air condensation may take place that will be difficult to completely remove.

If there is any evidence of moisture the equipment must be thoroughly dried either by blowing hot air through or by flushing with hot oil. In any case it is desirable to flush out the cooling equipment thoroughly with hot oil if at all possible. The radiators or coolers should be installed on the transformer the same day they are opened and not permitted to stand exposed overnight.

The object here is to keep the oil passages dry and completely clear of foreign material until installed.

SPECIAL TANK ASSEMBLIES

Some of the largest transformers may be designed with special tanks to facilitate shipment. Follow the instructions on the outline drawing and the special instruction book which accompanies the transformer, when making such an installation. The following general rules should be noted:

1. Form-fit tanks shipped on their sides should be erected in line with Instruction Leaflet 47-600-24. After erection, and before applying vacuum or filling with oil, remove any special braces between the top insulation structure and the tank.

2. When the transformer is in two sections, with the top section removed for shipment: If the unit is shipped in oil, it may be necessary to lower the oil to the midsection of the main tank in order to assemble the top section. If the unit is shipped in nitrogen it is recommended that the top section be assembled before applying vacuum or filling with oil. In all cases, exposure of the coils and insulation to air should be kept to a minimum. Exposure to damp air, or exposure longer than 48 hours may require re-drying the unit in the field.

3. When the top insulation structure is removed for shipment: Make the field assembly in line with

instructions on the outline drawing or special drawings accompanying the transformer. This top insulation structure, or bridge work, is usually bolted to the main insulation by means of fiber bolts and nuts. **When retightening fiber bolts and nuts it is not possible to apply the same force as with steel hardware without breakage.** Tighten to a snug fit only, without excessive stress in the bolt.

AUXILIARY GAS SPACE

Auxiliary gas spaces are sometimes used for increasing the effective gas space above the oil inside a transformer tank equipped with Inertiaire, for the purpose of securing less breathing. Sheet metal gas-and-oil-tight containers are mounted external to the main tank. The gas space inside these containers is connected to the gas space above the oil in such a manner that oil cannot enter these containers except when main transformer tanks have been flooded. Bleeder valves are provided for drawing off any oil which may find its way into these containers.

Since breathing out does not start until a definite pressure is reached, the more gas space used, the less breathing. This device is used only on large transformers where the breathing with the normal available gas space above the oil is not sufficient to prevent excessive consumption of nitrogen. This device is sometimes used on Sealedaire transformers.

FILLING WITH OIL

After all fittings are in place, the case is ready for the oil, if it is not already filled. The oil must be clean and free from moisture. In order to determine this, it must be tested before being put into the case, or, if already in the case, before the transformer is put into service. If the oil is in drums, samples must be taken from each drum. If the test is unsatisfactory, the oil must be purified.

When a transformer is shipped in nitrogen the tank should be opened or the gas-tight seal of the tank broken in dry weather only. Days of high humidity should be avoided if possible. It is desirable that the temperature of the core and coils be a few degrees centigrade higher than the ambient temperature, to prevent condensation of moisture on the core and coil assembly. Once the tank has been opened it should be filled with oil as soon as possible to prevent entrance of moisture.

Entrapped air is a potential source of trouble in all transformers. In general, therefore, it is desirable to fill transformers with oil under full vacuum. This is done for transformers shipped in oil from the

factory except in a very few cases where it is not considered essential.

In filling the transformer, be sure that valves and pipe connections between the main tank and all oil filled compartments are open for free circulation of gas and oil. Otherwise, trapped air or gas may cause the oil level in some part of the transformer to be below the safe operating level.

The tank should never be filled with oil before the cover of the tank is bolted in place; and in dismantling, the oil should be drained before removing the cover. This applies particularly to oval or other than round tanks with bolted covers.

When the 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 preferably be operated in that way for a few hours without load. It should be kept under observation during this time and also during the first few hours that it delivers load. After four or five days service it is advisable to test the oil again for moisture.

The filling of transformers with oil in the field should be done under a full vacuum provided the transformer tanks are designed for this condition. If the transformer tanks have not been designed for full vacuum and it is imperative to get the maximum impulse strength immediately, the transformers should be filled with oil under full vacuum by placing them in an auxiliary tank. Transformers with round wire coils should always be filled with oil under full vacuum, because of the higher stress across coil groups. For definite information on tank strengths where this information is not on the nameplate, the factory should be consulted before applying any vacuum.

The tank should be filled with oil at ambient temperature to the point on the oil gauge marked "25°C". The transformer should never be operated or left standing even out of service without the oil showing on the gauge. If the ambient temperature varies materially from 25°C (77°F) when the case is filled, the oil level should be checked when the average oil temperature is 25°C and if not at the marked oil level, sufficient oil should be put in or taken out to bring the level to the proper height.

NON-VACUUM FILLING

In cases where conditions do not permit vacuum filling, full voltage should not be applied to the

SHIPMENT AND INSTALLATION OF POWER TRANSFORMERS

transformer immediately after filling with oil. One of the following three methods should be used to hasten removal of entrapped air.

Method 1. (Preferred). After filling with oil, short circuit either the high voltage or low voltage windings and circulate from 50% to full load current in the windings to heat the oil and cause some thermal circulation. If the transformer is a forced oil cooled unit, pumps must be operating during this heating period. A close check should be kept on the transformer temperature to be sure no overheating takes place. Hot oil circulation tends to carry air bubbles to the surface of the oil where they are evolved in the gas space and also gives an accelerated rate of air absorption by the oil. The minimum time for this treatment is approximately 24 hours and depends on the voltage and kva rating of the unit being processed.

Method 2. If the transformer cannot be heated but has oil circulation pumps, the pumps should be operated to circulate the oil through the windings for at least 24 and preferably 48 hours after the unit is filled. This will tend to wash out air and carry bubbles to the oil surface where they can be evolved. Some air is likely to remain in the windings to be absorbed by the oil during normal operation.

Method 3. (Undesirable). If the unit cannot be heated and has no oil circulating pumps, it should be allowed to stand at least 48 hours (and preferably much longer) before applying full voltage to the transformer. This method is recommended only when method (1) or (2) is not feasible, as a fairly large volume of air may remain in the transformer windings. The air remaining in the insulation will have to be slowly absorbed by the oil. Thus, the insulation of the transformer may not reach its full impulse voltage strength for several months.

VACUUM FILLING

The recommended procedure for filling a power transformer with oil is to fill under as high a vacuum as conditions permit. It is essential to vacuum fill high voltage transformers shipped in nitrogen in order to develop their full insulation strength before they are energized.

The transformer tank must be sealed air tight except for the Vacuum and oil connections. For methods of closing breathers and other accessories that may allow air to enter the tank when the vacuum is applied see the instructions on the particular accessory. The vacuum is applied to the tank by connecting the vacuum pump to the one-inch pipe

tapped hole in the cover. This hole is plugged with a pipe plug when the transformer is shipped from the factory. The vacuum piping must be tight. The use of S#1744652 cement on threaded joints will materially assist in obtaining gas tight joints.

The oil is admitted to the tank through the upper filter press connection by suitable pipe connections.

Any vacuum pump may be used such as the Gast Rotary Vacuum Pump, Model 2565-V2, capable of maintaining a vacuum of 28 to 29 inches of mercury when corrected to a normal atmospheric pressure of 29.921 inches. The minimum vacuum, based on 29.921 inches, considered satisfactory for filling is 25 inches of mercury.

Leakage must be reduced to a minimum. A leak test is to exhaust the tank to as low a vacuum as possible and then close the valve in the vacuum line. If the vacuum in the tank decreases more than one inch of mercury in thirty minutes, the leaking is to be considered excessive and must be corrected.

After obtaining a vacuum of 28 to 29 inches of mercury corrected to normal atmospheric pressure on the transformer tank, the vacuum should be maintained by continuous pumping for at least four hours. The filling may then begin. The oil line should be connected to the upper filter press connection or other suitable connection on the top of the tank. The oil is admitted through this connection, the rate of oil flow being regulated by a valve at the tank so the vacuum does not fall below 25 inches of mercury. In any case, the oil flow should be controlled so the filling period is not less than four hours. For small units the vacuum will not determine the rate of oil flow.

CAUTION: Do Not Allow Transformer Oil To Enter The Vacuum Pump.

The oil should not spray in front of the vacuum opening in the tank and must not be allowed to overflow into the vacuum line. Transformer oil drawn into the vacuum pump may cause severe damage due to the close clearances or contaminate the oil in the vacuum pump by oil of high vapor pressure. Either of these conditions will probably stop pumping operations until repairs can be made or until another pump is connected to the tank.

Oil should be admitted to the transformer tank until the oil level reaches the 25° centigrade level or a level corresponding to the oil temperature if the oil is not approximately 25 degrees. After the oil reaches the proper level and the oil inlet valve is closed, the vacuum pumping should be continued

for approximately one hour before breaking the vacuum.

The vacuum should be broken by admitting dry nitrogen PDS-6306 to the gas space.

GROUNDING OF LOW-VOLTAGE WINDINGS

Every effort is made in insulating transformers to guard against any chance of breakdown between high-voltage and low-voltage windings, but, 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 if the high-voltage and the 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 winding grounded, the maximum voltage that can exist between any part of the low-voltage circuit and ground is one-half of the low voltage.

In all cases, the rules of the National Board of Fire Underwriters should be observed.

GROUNDING TRANSFORMER TANK

The tank of every power transformer should be grounded to eliminate the possibility of obtaining static shocks from it or of being injured by accidental grounding of winding to the case. A grounding lug is always provided on the base of the transformer for the purpose of grounding the case and fittings.



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

(Rep. 4-64) Printed in U.S.A.

www.ElectricalPartManuals.com

