

Installation of Transformers

INSTRUCTIONS

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.

Water-cooled transformers depend almost entirely upon the flow of water through the cooling coils for carrying away heat so that the temperature of the surrounding air has little effect upon that of the transformer. For this reason air circulation is of minor importance and water cooled transformers may be located in any convenient place without regard to ventilation.

Thermometers and outlets of water cooling coils should be on the front side of the case so that abnormal temperature or failure of water supply can be noted readily by an attendant.

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.

For indoor installation the room in which the transformers are placed must be well ventilated so that heated air can escape readily and be replaced by cool 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 the rise and the air temperature; therefore care must be taken to provide a room sufficiently well ventilated to permit operation of transformers at a reasonable temperature. The ambient temperature should not exceed 40°C.

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.

As with water-cooled transformers, the thermometer should be on the front side of the case where the temperature can be easily read.

Fire Risk—While the oil supplied with Westinghouse transformers will not take fire readily, it should be remembered that the possibility of catching fire is ever present and some precaution against fire should be taken. Transformers may be placed on a concrete floor surrounded by a ledge. Suitable means should be provided for drawing off the oil and extinguishing the fire.

CAUTION—Care must be taken in handling and installing transformers, particularly those wound for high voltage. As moisture is an enemy of insulation, 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, tools, nuts, or foreign matter of any kind dropped into the transformer may cause a breakdown or burnout.

SETTING UP

Where a transformer cannot be handled by a crane, it may be skidded or moved on rollers into place but in doing so care must be taken that it is not tipped over. A transformer with a round base is easily tipped over and should preferably be bolted to a temporary wooden frame or base before moving.

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.

In lifting a transformer when out of its case, a spreader may be necessary between the lifting ropes or chains in order to prevent them pressing against the terminal boards or insulation and damaging them.

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.

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 special features requiring attention during installation.

Precaution—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.

Centering—All transformers are provided with means of centering them in their cases. Different means of centering are:

- (1) A metal or wooden frame work.
- (2) Pieces of structural iron attached to bottom of transformer.
- (3) Lugs welded to bottom of case.

Cleaning—If the transformer is not shipped in the case, the inside of case should be thoroughly cleaned with dry cloths or waste. Particular care must

be taken to remove all traces of moisture, as even a small amount may cause serious trouble.

While the case is being made ready, the transformer should be kept in a dry place and if uncrated, covered with cloth to exclude dust or dirt. It should not be allowed to stand near open windows or doors, where water may blow in on it. It is very important that moisture be kept away from the transformer while it is out of its case. If it should get wet, it should be thoroughly dried out before putting into service.

In order to avoid the condensation of moisture on the transformer, large high voltage units should be kept at a temperature several degrees above the outside air temperature, as long as they are not immersed in oil.

Inspection—Before placing the transformer in its case, make a final inspection to see that it is thoroughly clean and all bolts and nuts are tight. In placing it in its case, handle it carefully and see that it is correctly centered. A light lowered into the case will facilitate this inspection.

When a transformer has been shipped in its case with the oil, it should be inspected for breakage, injury or displacements 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 case and tested. If the inspection and oil tests are satisfactory, the transformer is ready to be put into service. If the oil tests too low, 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.

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

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 a 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.

Installation Transformers—Continued

INSTRUCTIONS—Continued

Expansion Joints—Where the transformer is to be connected to an external system of piping for outlet bushings, oil or water connection, provision must be made for expansion and contraction to prevent throwing excessive stresses on the pipe connections which are welded into the tank 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 rust or scale from the oil lines entering the transformer tank.

Thermometer and oil gauge should be attached as shown on the outline drawing. Thermometers may be of the mercury type with or without alarm contacts, or the dial type with or without alarm contacts.

Cover—The cover should be bolted in position securely, care being taken that the gasket is properly placed so that the transformer is tightly closed. Use the gasket cement, Style No. 471880-E, shipped with the transformer for cementing all cork and cork composition gaskets. Follow the directions on the can.

Cover Bolts—It being commonly accepted in engineering practice that all non-circular vessels will distend when subjected to internal pressure, we would recommend lowering transformer oil to midsection of tank before disengaging cover bolts.

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 over stressing either angle ring or cover plate, drift pins should be driven into holes on either side 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 over compression of the gaskets.

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.

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 practically 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 test is unsatisfactory, the oil must be purified.

When a transformer is shipped in nitrogen the tank should be opened in dry weather only. The temperature of the core and coils should be higher than the ambient temperature, preferably 5° or 10°C. higher, 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 as essential.

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, the factory should be consulted.

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

The tank should be filled with oil at ambient temperature to the point on the oil gauge marked "Oil level" at "25°C. oil level". The transformer should never be operated or left standing even out of service without the oil showing in the gauge. If the ambient temperature varies materially from 25°C. 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.

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 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.

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.

GROUNDING OF LOW-VOLTAGE WINDING

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 windings 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, Pa.

Installation of Transformers

INSTRUCTIONS

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.

Water-cooled transformers depend almost entirely upon the flow of water through the cooling coils for carrying away heat so that the temperature of the surrounding air has little effect upon that of the transformer. For this reason air circulation is of minor importance and water cooled transformers may be located in any convenient place without regard to ventilation.

Thermometers and outlets of water cooling coils should be on the front side of the case so that abnormal temperature or failure of water supply can be noted readily by an attendant.

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.

For indoor installation the room in which the transformers are placed must be well ventilated so that heated air can escape readily and be replaced by cool 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 the rise and the air temperature; therefore care must be taken to provide a room sufficiently well ventilated to permit operation of transformers at a reasonable temperature. The ambient temperature should never exceed 40°C. with an average over twenty-four hours not exceeding 30°C.

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.

As with water-cooled transformers, the thermometer should be on the front side of the case where the temperature can be easily read.

Fire Risk—While the oil supplied with Westinghouse transformers will not take fire readily, it should be remembered that the possibility of catching fire is ever present and some precaution against fire should be taken. Transformers may be placed on a concrete floor surrounded by a ledge. Suitable means should be provided for drawing off the oil and extinguishing the fire.

CAUTION—Care must be taken in handling and installing transformers, particularly those wound for high voltage. As moisture is an enemy of insulation, 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, tools, nuts, or foreign matter of any kind dropped into the transformer may cause a breakdown or burnout.

SETTING UP

Where a transformer cannot be handled by a crane, it may be skidded or moved on rollers into place but in doing so care must be taken that it is not tipped over. A transformer with a round base is easily tipped over and should preferably be bolted to a temporary wooden frame or base before moving.

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.

In lifting a transformer when out of its case, a spreader may be necessary between the lifting ropes or chains in order to prevent them pressing against the terminal boards or insulation and damaging them.

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.

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 special features requiring attention during installation.

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Centering—All transformers are provided with means of centering them in their cases. Different means of centering are:

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- (2) Pieces of structural iron attached to bottom of transformer.
- (3) Lugs welded to bottom of case.

Cleaning—If the transformer is not shipped in the case, the inside of case should be thoroughly cleaned with dry cloths or waste. Particular care must

be taken to remove all traces of moisture, as even a small amount may cause serious trouble.

While the case is being made ready, the transformer should be kept in a dry place and if uncrated, covered with cloth to exclude dust or dirt. It should not be allowed to stand near open windows or doors, where water may blow in on it. It is very important that moisture be kept away from the transformer while it is out of its case. If it should get wet, it should be thoroughly dried out before putting into service.

In order to avoid the condensation of moisture on the transformer, large high voltage units should be kept at a temperature several degrees above the outside air temperature, as long as they are not immersed in oil.

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

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 a 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.

Installation of Transformers—Continued

INSTRUCTIONS—Continued

Expansion Joints—Where the transformer is to be connected to an external system of piping for outlet bushings, oil or water connection, provision must be made for expansion and contraction to prevent throwing excessive stresses on the pipe connections which are welded into the tank 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 rust or scale from the oil lines entering the transformer tank.

Thermometer and oil gauge should be attached as shown on the outline drawing. Thermometers and oil gauges are of the dial type with or without alarm contacts.

Cover—The cover should be bolted in position securely, care being taken that the gasket is properly placed so that the transformer is tightly closed. Use the gasket cement, Style No. 471880-E, shipped with the transformer for cementing all cork and cork composition gaskets. Follow the directions on the can.

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1. Insert all possible bolts.
2. In order to prevent over stressing either angle ring or cover plate, drift pins should be driven into holes on either side 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 over compression of the gaskets.

AUXILIARY GAS SPACE

Auxiliary gas spaces are sometime used for increasing the effective gas space above the oil inside a transformer tank equipped with Inertaire, 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 trans-

formers 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 practically 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 test is unsatisfactory, the oil must be purified.

When a transformer is shipped in nitrogen the tank should be opened in dry weather only. The temperature of the core and coils should be higher than the ambient temperature, preferably 5° or 10°C. higher, 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 as essential.

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, the factory should be consulted.

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

The tank should be filled with oil at ambient temperature to the point on the oil gauge marked "Oil level" at "25°C. oil level". The transformer should never be operated or left standing even out of service without the oil showing in the gauge. If the ambient temperature varies materially from 25°C. 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.

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 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.

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.

GROUNDING OF LOW-VOLTAGE WINDING

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 windings to the case. A grounding lug is always provided on the base of the transformer for the purpose of grounding the case and fittings.

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