# Instructions for Repairing Tank Leaks

I.L. 48-069-20C

This instruction leaflet is intended to give general instructions concerning recommended practices for repairing a weld leak in power transformers or their auxiliaries. Variations of these instructions may be desirable for special repair tasks, but normally the weld leak may be successfully sealed if these instructions are followed.

## TRANSFORMER CASES AND FITTINGS

Transformer cases and their fittings are fabricated from 3/16" to 1/2" thick welding quality low carbon steel, which are joined by manual, semi-automatic and automatic welding, using a manual shielded arc, submerged arc and inert arc process.

To repair a weld leak in a case seam or around one of the fittings the following is recommended:

1. Check the liquid level in relation to the area to be welded. It should be 4" or more above the area to be welded. Should the area to be welded be above the liquid level or if the liquid has been removed from the case, blanket the transformer with dry nitrogen.

2. De-energize the transformer and pull a vacuum of several pounds per square inch above the liquid to stop the liquid leak. This may be done with a vacuum pump or by sealing all fittings on the case and draining sufficient oil to obtain the necessary vacuum.

**NOTE:** Vacuum is not always required, especially when a sweating leak is to be repaired and the case wall is relatively thick.

3. Peen the weld leak closed, if possible, with the ball end of a ball-peen hammer or with a blunt or round-nosed chisel.

4. Grind or scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine.

5. Select a 1/8" diameter all purpose, coated electrode, American Welding Society type E-6012 (Westinghouse type FP). Either a-c or d-c welding current may be used. When d-c current is used, straight polarity is preferred, that is the electrode is negative.

The welding machine is adjusted to supply the desired welding current. Some value between 115 to 125 amperes should be used, depending upon the welding operator's ability and the individual task at hand.

6. Apply a string bead sealing weld over the weld defect in a single, quick pass. This weld should be deposited horizontally or vertically depending upon circumstances. If the weld is deposited vertically, it is recommended that it be made downward to drive any liquid seepage ahead of the weld.

Successive beads are deposited adjacent and over the first sealing bead, or a single pass may be weaved across it to complete the weld. If the beads are deposited vertically, deposit these beads from the top down if any liquid seepage is present; otherwise they may be deposited upward if preferred. Remove the slag from the deposited weld before depositing each successive weld bead or pass.

Liquid interferes with the welding operation and the quality of the deposited metal. It should be wiped off with a dry cloth. All welds should be deposited in a sequence as above to prevent any liquid seepage interfering with the welding operation other than the final sealing at the lowest point of the weld leak.

7. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

Effective November, 1962 Supersedes I.L. 48-069-20B, July, 1962

Drain the liquid from the radiator and remove the radiator from transformer case.

2. Grind or scrape the paint from the area to be repaired. Also remove any liquid, dirt or foreign matter.

3. If the weld to be repaired is around the header flange use 1/8" diameter type E-6012 electrodes with current settings between 115 to 125 amperes. Weld horizontally around the flange.

4. A slightly reducing oxygen-acetylene welding flame is recommended for repairing a weld along the edge of an element, a weld joining the elements to each other, or a weld joining the elements to the header. The recommended procedure for repairing a leak along the edge of an element is outlined below:

a. Heat the full length of the seam with the oxy-acetylene torch to drive out all trapped oil.

b. Find the exact location of the leak by means of a suitable leak detector.

c. When the exact location of the leak has been determined, notch the edge of the element as shown in Figure 2 at points two to three inches on either side of the leak. These notches may be cut with a hack saw, a file, or a small grinder.

d. Start by filling one of the notches. Next, fill in the second notch. Finally fuse the edges of the element between the notches moving forward with a slightly weaving motion. Be sure to tie this weld into both filled notches. Use 1/16" soft iron gas welding rod as filler material.

Figure 3 shows the repaired element before touching up the repaired area.

5. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

6. After testing for leaks, reclean the area and apply touch-up paint as outlined in I.L. 47-600-12, "Standard Outside Finish for Westinghouse Oil Insulated Transformers."

7. Reinstall the radiator.

## YUKON COOLERS

"Yukon" Coolers are formed by corrugating sections of the tank wall and are integral with the tank wall. The thickness of these coolers is usually 5/16" which corresponds to the wall thickness of network transformers on which they are primarily used. Since they are the same thickness as the tank wall and consist mostly of flat surfaces, the procedure for repairing weld leaks is the same as given under the information on the first page of this leaflet under "Transformer Cases and Fittings."



**Westinghouse Electric Corporation**
Power Transformer Division, Sharon, Pa.

Printed in U.S.A. (TP)

APPLICATION • INSTALLATION • INSPECTION

# INSTRUCTIONS

## GASKETS
### for Liquid Filled Transformers Tap Changers and Regulators

**GASKET APPLICATION**

| APPARATUS | GASKET MATERIAL | GASKET CEMENT | % GASKET COMPRESSION |
|---|---|---|---|
| Oil Insulated* Apparatus | Cork Neoprene PDS#7249-11 or 45721AH(1) | #8440-4 | 43% |
| | Nitrile PDS#12160-715.1 or 45351EH | None | 25% |
| Inerteen Insulated and Network Transformers | Cortite Nitrile PDS#9950-3 or MC45711AA(1) | #7386-1 | 50% |
| "URS" and "URT" Tap Changers and Regulators | Cork Neoprene PDS#7249-11 or 45721AH Flat Gaskets-No Gasket Stops | #8440-4 | 43% |
| | Dumbell Nitrile Section #258A460 or 45351EP | None | .... |

* Except "URS" and "URT" Tap Changers and Regulators.
(1)-Temporary shipping gaskets may be cork—for permanent application PDS#7249-11, 45721AH, 9950-3 or MC45711AA should be used.

## GENERAL

The gaskets used on liquid filled transformers, tap changers and regulators are of materials which have proven suitable for that particular apparatus with which they are being used. Experience has shown that the use of the proper material used with the correctly associated apparatus and installed by a standard procedure assures a joint that will be leakproof.

## GASKET INSTALLATION

**A. Preparing Metal Surfaces.** Before applying a gasket to any metal surface care must be taken to assure that the mating surfaces are free of ice, dew condensation, oil, grease, rust or dirt by wiping dry. This can be done by using clean rags or any other method that will assure a dry surface. Rust should be removed by sanding or wire brushing. Thin uniform films of primer paint or gasket cement need not be removed. If the gasket is cut in the field, cut the gasket to conform to the surfaces to be sealed. Gasket thickness and percent compression must be in accordance with recommended practice. If the gasket is not a one-piece gasket, scarf the ends of the gasket so that the length of the overlap will be equal to four times the thickness of the gasket material. The mitering should be done with a fine toothed saw and a miter box to assure a clean uniform cut and to obtain full gasket thickness at the lap joint. A hand-type gasket cutter for keystone shaped interlocked joints is available for field work. These interlocked joints must be matched-cut by forming the joint properly and cutting both layers at the same time. Gasket cutting tool (up to 3 inches), style number 328B614G01. When ordering precut gaskets, give the complete nameplate reading of the transformer including serial number. Specify exact description of the gaskets required and give their location.

**B. Application of Permanent Gaskets when temperatures are above freezing.** It is recommended that both sides of the gasket be cemented to the gasket surfaces. Apply cement as follows:

#8440-4 Cement

1. Apply cement to both gasket and joint surfaces and let dry at least ten minutes but not more than 60 minutes.
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**Application of Permanent Gaskets when temperatures are below freezing.** To keep the gasket from getting too hard and to keep the cement fluid, the gaskets and cement should be kept at a minimum temperature of 35°F up to the time of actual application of cement and compression of gaskets. This will mean that the cement and gaskets will usually have to be kept warmer than this in freezing weather. It will not be necessary to coat the gasket groove with #8440-4 cement providing the gasket is assembled with the mating parts before the cement is completely set-up. By following these instructions you can be sure that the gasket will not be too hard to compress properly and the cement will adhere to the metal surfaces assuring an oil-tight seal.

**#7386-1 Cement**

1. Apply cement to both gasket and joint surfaces and let dry until "tacky".
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**C. Inspection Opening Gaskets.** Gaskets for inspection openings may be sealed on one side only to permit the removal of the inspection cover without destroying the gasket. It is recommended that the gasket be sealed to the stationary member of large openings and to the cover of small openings and load tap changer oil compartment doors. The gasket is sealed to one member by applying a uniform coating of gasket cement (for cork-neoprene use PDS#8440-4 S#1608171A; for "Cortite" or cork use PDS#7386-1 S#1150419) to one side of the gasket and to the surface to which the gasket is cemented. It is suggested that the surface of the gasket not cemented be coated with silicone lubricant M-5861-4 S#228A253H01, to prevent the vulcanizing of the gasket material to the steel plate. This will permit the removal of the cover without destroying the gasket.

For cemented surface follow cementing instructions above.

Prior to replacing a cover of an inspection opening, the gasket should be examined to make certain that it has not been damaged and that it has sufficient thickness to reseal the joint.

## MANHOLE COVER AND BUSHING FLANGE GASKETS

Gaskets for manhole covers should be sealed to the main cover boss opening to permit the removal of the manhole cover without destroying the gasket.

Bushing flange gaskets are sealed in permanently when the bushings are installed. Follow procedure for application of permanent gaskets.

*NOTE: It is very important that all openings in the transformer tank and tap changer be tightly closed before putting a unit into operation. This is necessary whether the unit is for indoor or outdoor operation. For all liquid filled tap changers and regulators; the bushing flanges, main cover, manhole covers, etc. must be oil and gas tight.*

## LEAKAGE TESTS

Liquid filled transformers should be tested for pressure tightness prior to putting in service. The permissible internal pressure that may be used can be determined from the nameplate on the transformer. Internal test pressures of ten pounds per square inch may be used to check the tightness of gasketed joints for transformers whose nameplates indicate that the transformer may be filled under complete vacuum. All other transformers should be tested with an internal pressure of five pounds per square inch.

The following precautions should be observed when making the pressure test:

1. Inertaire transformers;—Close the valves or disconnect the piping and plug the entrances into the tank before testing.

2. Open air breathers, dehydrating breathers, and breathing regulators: Close openings to this equipment before testing.

3. Mechanical relief device:—The relief device must be replaced by a steel plate when the test pressure is likely to exceed the tripping pressure of the relief device. For additional instructions, refer to the instruction leaflet for relief device.

4. Relief diaphragm:—A relief diaphragm must be replaced by a steel diaphragm when the test pressure is likely to exceed the rupturing pressure of the relief diaphragm. For additional instructions, refer to the instruction leaflet for relief diaphragm.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.
(Rep. 3-64) Printed in U.S.A.

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## TRANSFORMER CASES AND FITTINGS

Transformer cases and their fittings are fabricated from 3/16" to 1/2" thick welding quality low carbon steel, which are joined by manual, semi-automatic and automatic welding, using a manual shielded arc, submerged arc and inert arc process.

To repair a weld leak in a case seam or around one of the fittings the following is recommended:

1. Check the liquid level in relation to the area to be welded. It should be 4" or more above the area to be welded. Should the area to be welded be above the liquid level or if the liquid has been removed from the case, blanket the transformer with dry nitrogen.

2. De-energize the transformer and pull a vacuum of several pounds per square inch above the liquid to stop the liquid leak. This may be done with a vacuum pump or by sealing all fittings on the case and draining sufficient oil to obtain the necessary vacuum.

**NOTE: Vacuum is not always required, especially when a sweating leak is to be repaired and the case wall is relatively thick.**

3. Peen the weld leak closed, if possible, with the ball end of a ball-peen hammer or with a blunt or round-nosed chisel.

4. Grind or scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine.

5. Select a 1/8" diameter all purpose, coated electrode, American Welding Society type E-6012 (Westinghouse type FP). Either a-c or d-c welding current may be used. When d-c current is used, straight polarity is preferred, that is the electrode is negative.

The welding machine is adjusted to supply the desired welding current. Some value between 115 to 125 amperes should be used, depending upon the welding operator's ability and the individual task at hand.

6. Apply a string bead sealing weld over the weld defect in a single, quick pass. This weld should be deposited horizontally or vertically depending upon circumstances. If the weld is deposited vertically, it is recommended that it be made downward to drive any liquid seepage ahead of the weld.

Successive beads are deposited adjacent and over the first sealing bead, or a single pass may be weaved across it to complete the weld. If the beads are deposited vertically, deposit these beads from the top down if any liquid seepage is present; otherwise they may be deposited upward if preferred. Remove the slag from the deposited weld before depositing each successive weld bead or pass.

Liquid interferes with the welding operation and the quality of the deposited metal. It should be wiped off with a dry cloth. All welds should be deposited in a sequence as above to prevent any liquid seepage interfering with the welding operation other than the final sealing at the lowest point of the weld leak.

7. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

Effective November, 1962 Supersedes I.L. 48-069-20B, July, 1962

Drain the liquid from the radiator and remove the radiator from transformer case.

2. Grind or scrape the paint from the area to be repaired. Also remove any liquid, dirt or foreign matter.

3. If the weld to be repaired is around the header flange use 1/8" diameter type E-6012 electrodes with current settings between 115 to 125 amperes. Weld horizontally around the flange.

4. A slightly reducing oxygen-acetylene welding flame is recommended for repairing a weld along the edge of an element, a weld joining the elements to each other, or a weld joining the elements to the header. The recommended procedure for repairing a leak along the edge of an element is outlined below:

a. Heat the full length of the seam with the oxy-acetylene torch to drive out all trapped oil.

b. Find the exact location of the leak by means of a suitable leak detector.

c. When the exact location of the leak has been determined, notch the edge of the element as shown in Figure 2 at points two to three inches on either side of the leak. These notches may be cut with a hack saw, a file, or a small grinder.

d. Start by filling one of the notches. Next, fill in the second notch. Finally fuse the edges of the element between the notches moving forward with a slightly weaving motion. Be sure to tie this weld into both filled notches. Use 1/16" soft iron gas welding rod as filler material.

Figure 3 shows the repaired element before touching up the repaired area.

5. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

6. After testing for leaks, reclean the area and apply touch-up paint as outlined in I.L. 47-600-12, "Standard Outside Finish for Westinghouse Oil Insulated Transformers."

7. Reinstall the radiator.

## YUKON COOLERS

"Yukon" Coolers are formed by corrugating sections of the tank wall and are integral with the tank wall. The thickness of these coolers is usually 5/16" which corresponds to the wall thickness of network transformers on which they are primarily used. Since they are the same thickness as the tank wall and consist mostly of flat surfaces, the procedure for repairing weld leaks is the same as given under the information on the first page of this leaflet under "Transformer Cases and Fittings."

DESCRIPTION • INSTALLATION

# INSTRUCTIONS

## UNIT SUBSTATION THROAT HOUSING

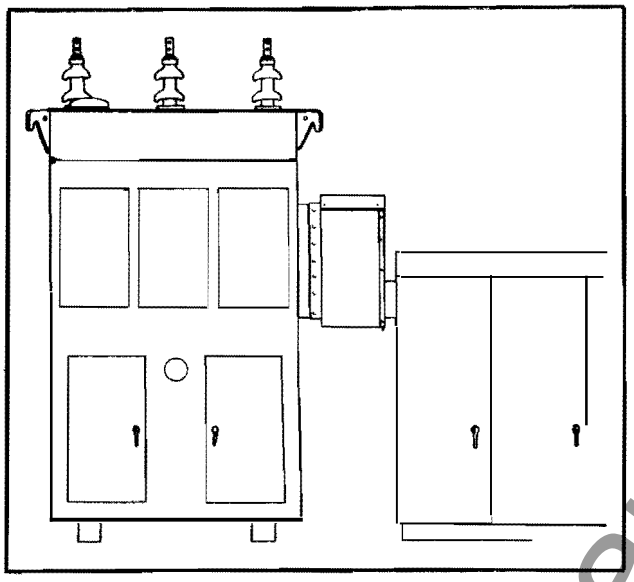

FIG. 1. Outline Showing Throat Housing In Use

**THE UNIT SUBSTATION THROAT HOUSING** is designed to permit greater flexibility in transformer design while allowing the designer of the metal-clad switchgear to use standardized units. It also permits installation of larger or smaller transformer units with a minimum of expense and labor. This design has improved weather properties, allows for variations in the foundation due to settling, and for slight variations in the manufacture of both the transformer and the switchgear units and is designed so as not to transmit transformer noise.

Permanent alignment of the transformer and switchgear depends upon the degree of care taken in constructing the foundations. However, it is economically impractical to construct a foundation to prevent all settling. The weather-proofing adjusting plate around the switchgear throat has a ½ inch clearance on all sides. This space is weather-proofed with a ¾ inch synthetic rubber tubular gasket which is cemented to the adjusting plate. This gasket gives a tolerance of ±¼ inch to allow for manufacturing variations in the switchgear throat. In addition, provisions have been made to give a ±1-inch variation in a vertical direction to allow for corrections due to foundation settling.

### INSTALLATION

In most cases, except where shipping clearances do not permit, the housing is shipped already assembled on the transformer throat, in order to protect and enclose the bus bar connections also already assembled. (The adjusting plate and its tie-plates are usually shipped separately).

When the housing is shipped attached to the transformer throat, it must be removed before installation can proceed. It is necessary to lower the housing away from the transformer throat, as follows:

**1.** Remove the top cover. (Refer to Fig. 2.)

**2.** Remove the front cover. (See Fig. 3.)

**3.** Loosen the clamp plates on each side of the transformer throat. (See Fig. 5.)

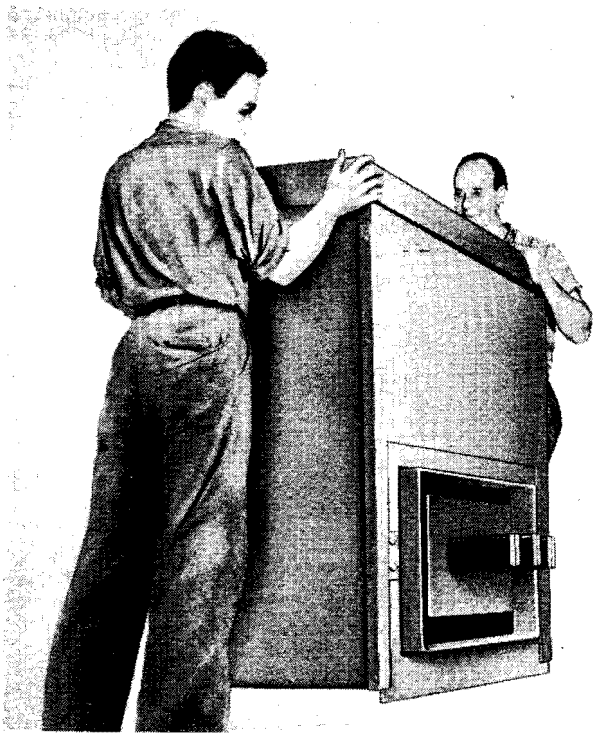

FIG. 2. Removing Top Cover of Throat Housing

APPLICATION • INSTALLATION • INSPECTION

# INSTRUCTIONS

## GASKETS
### for Liquid Filled Transformers Tap Changers and Regulators

**GASKET APPLICATION**

| APPARATUS | GASKET MATERIAL | GASKET CEMENT | % GASKET COMPRESSION |
|---|---|---|---|
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| Inerteen Insulated and Network Transformers | Cortite Nitrile PDS#9950-3 or MC45711AA(1) | #7386-1 | 50% |
| "URS" and "URT" Tap Changers and Regulators | Cork Neoprene PDS#7249-11 or 45721AH Flat Gaskets-No Gasket Stops | #8440-4 | 43% |
| | Dumbell Nitrile Section #258A460 or 45351EP | None | .... |

* Except "URS" and "URT" Tap Changers and Regulators.
(1)-Temporary shipping gaskets may be cork—for permanent application PDS#7249-11, 45721AH, 9950-3 or MC45711AA should be used.

### GENERAL

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### GASKET INSTALLATION

**A. Preparing Metal Surfaces.** Before applying a gasket to any metal surface care must be taken to assure that the mating surfaces are free of ice, dew condensation, oil, grease, rust or dirt by wiping dry. This can be done by using clean rags or any other method that will assure a dry surface. Rust should be removed by sanding or wire brushing. Thin uniform films of primer paint or gasket cement need not be removed. If the gasket is cut in the field, cut the gasket to conform to the surfaces to be sealed. Gasket thickness and percent compression must be in accordance with recommended practice. If the gasket is not a one-piece gasket, scarf the ends of the gasket so that the length of the overlap will be equal to four times the thickness of the gasket material. The mitering should be done with a fine toothed saw and a miter box to assure a clean uniform cut and to obtain full gasket thickness at the lap joint. A hand-type gasket cutter for keystone shaped interlocked joints is available for field work. These interlocked joints must be matched-cut by forming the joint properly and cutting both layers at the same time. Gasket cutting tool (up to 3 inches), style number 328B614G01. When ordering precut gaskets, give the complete nameplate reading of the transformer including serial number. Specify exact description of the gaskets required and give their location.

**B. Application of Permanent Gaskets when temperatures are above freezing.** It is recommended that both sides of the gasket be cemented to the gasket surfaces. Apply cement as follows:

#### #8440-4 Cement

1. Apply cement to both gasket and joint surfaces and let dry at least ten minutes but not more than 60 minutes.
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**Application of Permanent Gaskets when temperatures are below freezing.** To keep the gasket from getting too hard and to keep the cement fluid, the gaskets and cement should be kept at a minimum temperature of 35°F up to the time of actual application of cement and compression of gaskets. This will mean that the cement and gaskets will usually have to be kept warmer than this in freezing weather. It will not be necessary to coat the gasket groove with #8440-4 cement providing the gasket is assembled with the mating parts before the cement is completely set-up. By following these instructions you can be sure that the gasket will not be too hard to compress properly and the cement will adhere to the metal surfaces assuring an oil-tight seal.

**#7386-1 Cement**

1. Apply cement to both gasket and joint surfaces and let dry until "tacky".
2. Assemble gasket and press firmly into place.
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For cemented surface follow cementing instructions above.

Prior to replacing a cover of an inspection opening, the gasket should be examined to make certain that it has not been damaged and that it has sufficient thickness to reseal the joint.

## MANHOLE COVER AND BUSHING FLANGE GASKETS

Gaskets for manhole covers should be sealed to the main cover boss opening to permit the removal of the manhole cover without destroying the gasket.

Bushing flange gaskets are sealed in permanently when the bushings are installed. Follow procedure for application of permanent gaskets.

*NOTE: It is very important that all openings in the transformer tank and tap changer be tightly closed before putting a unit into operation. This is necessary whether the unit is for indoor or outdoor operation. For all liquid filled tap changers and regulators; the bushing flanges, main cover, manhole covers, etc. must be oil and gas tight.*

## LEAKAGE TESTS

Liquid filled transformers should be tested for pressure tightness prior to putting in service. The permissible internal pressure that may be used can be determined from the nameplate on the transformer. Internal test pressures of ten pounds per square inch may be used to check the tightness of gasketed joints for transformers whose nameplates indicate that the transformer may be filled under complete vacuum. All other transformers should be tested with an internal pressure of five pounds per square inch.

The following precautions should be observed when making the pressure test:

1. Inertaire transformers;—Close the valves or disconnect the piping and plug the entrances into the tank before testing.
2. Open air breathers, dehydrating breathers, and breathing regulators: Close openings to this equipment before testing.
3. Mechanical relief device:—The relief device must be replaced by a steel plate when the test pressure is likely to exceed the tripping pressure of the relief device. For additional instructions, refer to the instruction leaflet for relief device.
4. Relief diaphragm:—A relief diaphragm must be replaced by a steel diaphragm when the test pressure is likely to exceed the rupturing pressure of the relief diaphragm. For additional instructions, refer to the instruction leaflet for relief diaphragm.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.
(Rep. 3-64) Printed in U.S.A.

# Instructions for Shipment, Installation & Storage of Small Power Transformers

## South Boston Units

**Westinghouse Electric Corporation**
**SMALL POWER TRANSFORMER DIVISION, SOUTH BOSTON, VIRGINIA**
I.L. 48-069-40 Effective May, 1972

# Contents

## INTRODUCTION

This leaflet gives procedures to be followed from the time a transformer is received until it is energized. These instructions apply to transformers shipped from the Small Power Transformer Division at South Boston, Virginia. They do not necessarily apply to transformers shipped from other manufacturing locations.

## SHIPPING PRACTICES

Transformers are shipped from the South Boston Works as complete units ready to energize without opening the transformer tank where possible; that is, with bushings installed with insulating liquid to the correct liquid level, with thermometers, pressure gauges etc. installed on the tank. Some items are necessarily removed to either prevent damage during shipment or to meet shipping dimensional requirements. When items are removed for shipment they are specified on the outline drawing. Any external bracing required for shipment which must be removed during installation will be shown on outline or detail drawings and painted yellow.

Transformers will be shipped without liquid in dry nitrogen only when this is required by the customer's contract.

Unless otherwise specified by the customer all equipment will be shipped by motor truck. Impact recorders are not necessary and will not be used.

Some items manufactured at other factory locations will be shipped direct to the customers shipping locations. These items are shown on the outline drawing as "shipped direct."

## PRECAUTIONS

**Safety. Normal good safety practices must be followed during the inspection and installation of transformers. In addition, there are procedures that are more or less peculiar to transformers which should be followed for the protection of workmen and of the transformer.**

**The transformer tank must be grounded at all times. Windings and bushings must be grounded except when electrical tests are being made. All fluid handling equipment and vacuum pumps must also be grounded. This will reduce the possibility of static discharges.**

**Electrical tests must not be performed when vacuum is applied to the transformer if such test produces a potential of more than 125 volts anywhere in the transformer.**

**Fire extinguishers should be provided for emergency use. One should be available on top of the transformer when work is being done inside the tank. No smoking should be permitted on top of the transformer when any covers are opened or in the vicinity of the oil handling equipment. NOTE: It should be realized that the use of a fire extinguisher inside the transformer will usually severely damage or ruin the transformer insulation. $CO_2$ extinguishers cause the least damage.**

**Before removing any covers or fittings from the transformer make certain that there is zero gauge pressure in the tank and the fluid level is not above that particular opening.**

**Never allow anyone to enter the transformer tank unless an analysis of the air in the tank shows at least 18% oxygen. Whenever anyone is in the tank, a man should be stationed at the manhole outside the tank.**

**Lights must be explosion proof and have oil resistant cords.**

**Avoiding Transformer Damage.** Transformers are generally shipped sealed and ready for energizing without opening the tank. In cases where it is necessary to open the tank for changing terminal board connections or installing high voltage bushings extreme care is required to protect the insulation from damage. Internal parts are located to

provide the necessary electrical clearances and must not be bent or moved out of position. All contaminating materials must be kept out of the tank.

While the transformer is open no one should be permitted on top of the transformer until he has emptied all pockets, checked for loose objects elsewhere on his person, such as in pants cuffs, and has removed watches and rings.

Persons entering the transformer must not have loose dirt particles on their clothing. Clean cloth shoe covers or nitrile rubber overshoes must be worn by anyone entering the tank.

Never stand directly on any electrical insulation.

Clean drop cloths should be used under working areas in the transformer to prevent objects from dropping into the structure.

All tools must be accounted for. If possible, tools should have lines attached so that they cannot be lost.

One person should be responsible for policing the people and materials into and out of the tank and for making certain that nothing is left in the tank accidentally. This person should also be responsible for limiting the length of time the tank is left open as specified on page 3.

In the event of sudden weather changes, threatening rain or snow, provisions should be made for closing the tank quickly to protect the insulation.

If any object is dropped into the transformer and cannot be retrieved, a Westinghouse representative must be notified immediately.

Do not conduct vacuum operations when it is raining or while the transformer is unattended.

The use of pressure gauges containing mercury should be avoided unless an effective trap is placed between the gauge and the transformer because of the possibility of an accident resulting in mercury getting into the transformer. For measuring vacuum, **properly calibrated** thermo-couple gauges or aneroid absolute pressure gauges are preferred.

In most cases it is not necessary nor desirable to open the transformer tank. There are no internal braces to be removed.

The voltages of the high voltage circuit and the low voltage circuit must match the transformer voltages as shown on the nameplate. The tap changers must be set on the correct positions. The transformers must also be phased out correctly before closing the circuits. Energizing the transformer at the wrong voltage or out of phase may result in damage requiring complete rebuilding of the internal parts.

## RECEIVING INSPECTION

**Drawings and Documents.** Shipping papers, outline drawings, instruction leaflets and other pertinent documents furnished with the transformer must be available for use during the inspection.

**External Inspection.** External inspection prior to unloading the transformer should include all of the items in the check list below. Any external evidence of damage or evidence indicating the possibility of hidden damage must be reported to the carrier's representative and to a Westinghouse representative before unloading the transformer.

**Insulation Dryness.** Drying operations in the factory reduce the moisture content to a very low level. This dry condition should be maintained. The amount of moisture can be estimated by a dewpoint measurement for units shipped in nitrogen, or by measurement of insulation resistance or of insulation power factor for units shipped in liquid if there is any reason to question the dryness.

The dewpoint can be measured using a dry ice dewpoint apparatus, or with a Panametrics Alumi-

**CHECK LIST**

**External Inspection of Transformer**

**Blocking and Tie Rods**

1. Are all tie rods or chains undamaged and nuts tight.
2. Is all blocking tight and in good conditions?
3. Is there any evidence of load shifting in transit?

**Transformer Tank and Fittings**

4. Are there indications of external damage?
5. Is the paint finish damaged?
6. Are all fittings which were shipped attached still in place and undamaged?
7. Is there any evidence of liquid leakage?

**Bushings (when shipped attached)**

8. Are any porcelains chipped or otherwise damaged?

num Oxide Hygrometer (Panametrics, Inc., 221 Crescent Street, Waltham, Massachusetts 02154). An estimate must be made of the average temperature of the transformer insulation. This will require some judgment, depending upon the weather conditions and exposure of the transformer to wind and direct sun. The gas in the transformer should be at a slight positive gauge pressure, preferably not higher than 2 psi gauge when the dewpoint is measured.

Insulation resistance and power factor measurements should be made and compared with measurements made at the factory.

Factory measurements of insulation and power factor are obtained with the unit liquid filled. Therefore, direct comparison of these quantities when measured with gas instead of liquid in the unit is not possible.

If there are indications of moisture in the insulation the factory should be contacted immediately for confirmation of the analysis of the measurements, and for recommendations for the drying procedure to be followed.

If the transformer is opened, the time the transformer is open should not exceed 2 hours after which the transformer should be sealed.

It may be necessary to remove some liquid from liquid-filled units. If this is done, refilling of the transformer must be done as specified in FINAL FILLING, page 6.

**Electrical Tests**. If any damage is suspected, the following tests must be made:

a. A ratio test should be made on all windings and taps. If any measurement is off ratio by more than 0.5%, resistance measurements should be made of the winding in question and compared with factory test values.

b. Insulation resistance of each winding to all other windings and ground and from all windings to ground should be made with the windings under liquid. These readings should be comparable with measurements made at the factory.

**Detail Parts.** All detail parts should be checked against the packing list to make certain that there are no shortages. The crates and boxes should be carefully examined for evidence of damage.

In making examinations of any parts or crates for shipping damage, check carefully for evidence of the entrance of moisture and for damage to the moisture barriers or waterproof wrappings.

Accessories and detail parts should be placed in a location which will minimize exposure to weather and the possibility of damage or loss. If

the transformer is not to be installed immediately, the parts must be stored in accordance with Storage of Unmounted Accessories.

**Paint Finish.** Inspect the paint finish on the main transformer tank and on all painted detail parts for damaged areas. Apply touchup paint to these areas.

## HANDLING

Transformers must be handled in the normal upright position unless instructions have been received to the contrary.

Lifting hooks or eyes are provided for crane lifting. When the transformer is lifted, all hooks or eyes must be used. Similarly, jacking areas are provided for lifting the transformer with jacks. All such areas must be used when the transformer is to be jacked.

When the transformer has a removable top section or a bolted main cover, the top section or cover must be bolted in place when lifting.

Check the outline drawing for any required special equipment or procedures to be used in lifting.

Never attempt to lift the transformer by using cranes or jacks on any part of the transformer other than the fittings or jacking areas provided for this purpose.

## STORAGE PRIOR TO ENERGIZING

**Temporary Storage. (Up to 3 months) Without Liquid in Nitrogen.** If the transformer cannot be installed immediately upon arrival, and liquid filling is impractical, it is permissible to store the transformer in nitrogen for up to three months, after date of arrival at the site.

The storage of transformers in nitrogen requires positive assurance that the gas pressure is continuously maintained. The best method of accomplishing this is by use of Inertaire equipment. If the transformer is not equipped for Inertaire, temporary pipe connections can be made using the upper filter press or vacuum filling connections. The Electric Service Department can obtain upon request the necessary Inertaire equipment for proper storage.

The transformer must be placed on a solid level foundation in the storage area. The Inertaire equipment must be installed within one week after the transformer has been delivered. Ground the tank and any bushings that are mounted.

After installing the Inertaire equipment with a full cylinder of dry nitrogen pressure test the transformer for four hours at three psi gauge pressure. Check the tank for leaks with soap suds. After pressure testing, set the Inertaire equipment for normal operation. A positive nitrogen pressure must be maintained at all times.

Transformer gas pressure and cylinder pressure should be recorded every day for the first two weeks. These readings should preferably be taken at approximately the same time every day and the time and temperature also noted on the log. After two weeks of daily logging with stable conditions the frequency of pressure readings may be reduced to once a week. An accurate log is important as it may be the determining factor in any decision that may have to be made on further drying of the windings. Follow the instructions for the particular Inertaire equipment used or information provided by the Engineering and Service Departments. Transformers should not be stored more than three months without being filled with liquid.

To place the unit in service, the same procedure must be followed as though the transformer had just been received. When vacuum filling with liquid the length of the vacuum period prior to liquid filling specified in Table I, page 5, shall be increased by four hours.

**Storage in Liquid.** If the transformer is to be stored for more than three months it should be filled with liquid. The transformer will then be

| TABLE 1 – VACUUM TREATMENT AND LIQUID FILLING | | |
|---|---|---|
| CONDITION | 15 P.S.I. OR FULL VACUUM TANKS | |
| | ABSOLUTE PRESSURE IN TANK TORR | VACUUM HOLDING TIME HOURS |
| Before Filling | 5 Maximum | 4 |
| During Filling | 6 Maximum | - |
| After Filling | 5 Maximum | 2 |
| | 8 P.S.I. TANKS | |
| Before Filling | 347 Minimum | 4 |
| During Filling | 347 Minimum | - |
| After Filling | 347 Minimum | 2 |
| | 5 P.S.I. TANKS | |
| Before Filling | 502 Minimum | 4 |
| During Filling | 502 Minimum | - |
| After Filling | 502 Minimum | 2 |
| NOTE: 1 TORR = 1 mm Hg = .0193 P.S.I. | | |
| CAUTION: Where "MINIMUM" is specified lower pressures may result in tank damage or permanent deformation with serious damage to internal parts. | | |

ready for service at any time providing it receives the same inspection and maintenance as a transformer in service.

At the end of the storage period samples of liquid should be drawn from the transformer and tested for electrical strength and water content. Make megger and power factor tests on each winding to other windings and to ground and from all windings to ground and compare with factory test values. If all test results are satisfactory, completely assembled units may be energized. Installation of other transformers should be completed as specified.

**Separate Storage of Unmounted Accessories.** When accessories are not mounted immediately after the transformer is received they must be given care to protect them from damage or loss during storage. The following general instructions and the more detailed instructions given in instruction leaflets for the accessories, when furnished, must be followed. In the event of conflict between this leaflet and the instruction leaflet for the individual accessory the latter shall take precedence.

**Bushings.** The bushings when shipped detail are crated or boxed. The lower end of the bushing is covered with a plastic bag to keep it clean and dry. The plastic bags on Type S and Type OS bushings contain a bag of silica gel. Examine for signs of moisture inside the plastic bags. If the bags are damaged replace the bags and the silica gel before storing.

It is best to store condenser bushings in a clean, dry place indoors in their shipping crates. Type "O" bushings must be stored with the top end elevated at an angle of at least 20° from the horizontal above the bottom end. They may be stored in the shipping box.

**Detail Box.** Store the box, containing details as shipped, indoors and in a dry place. The box contains Inertaire connections, gaskets, paint, gasket cement, sudden pressure relay, etc., as specified on the detail packing list.

**Inertaire.** The Inertaire cabinet is shipped on the transformer when shipping clearances permit. The pressure gauge and reducing valves (one assembly), three-way valve, sump, and plastic hoses are assembled and in the cabinet. Flexible tubing for connecting the nitrogen tank to the cabinet is shipped in the detail box. The nitrogen tank must be assembled to the transformer before the transformer is stored or any work is started.

Indoor storage is required for all items marked FRAGILE and for porcelain stored more than one month.

**Drawings and Other Documents.** The outline drawing for the transformer must be checked carefully. The circuit diagram and nameplate should also be observed closely in planning and performance of all work. Instruction leaflets for accessory equipment must be followed.

## FINAL FILLING OF TRANSFORMERS SHIPPED IN NITROGEN

The temperature of the core and coils must be above 0°C during the vacuum and vacuum filling operations.

**Vacuum Equipment and Procedures.** In order to attain the vacuum levels specified and to maintain these levels during oil filling a good vacuum pump of adequate capacity will be needed. A 100 cfm pump will be adequate. The pumps should be capable of attaining a blankoff pressure of .02 Torr or less for 15 psi or full vacuum tanks.

Connections from the pump to the transformer tank should be as short and as large in diameter as possible. The line should be at least 1 inch in diameter, and preferably larger. There should be no low spots in the vacuum line in which liquid can collect.

The pressure in the tank during vacuum operations should be measured through a connection to the top section of the tank above the liquid level. Do not use pressure measurements at locations other than the tank itself. For measuring the pressure in the tank a properly calibrated aneroid gauge or thermocouple gauge is recommended. Use mercury gauges only if a trap is provided which will prevent mercury from entering the transformer.

It is important that the entire system be as free from leaks as possible. Otherwise it may be difficult or impossible to attain the specified vacuum levels. Also, any leaks will permit moist air or water to be drawn into the transformer. If a high capacity pump is used it is especially important to eliminate leaks so that moisture drawn into the system is minimized.

Openings for relief devices and other accessories must be sealed in accordance with instructions furnished for the particular accessory in order to prevent air from entering the transformer during vacuum operations. Valves in pipe connections between the main tank and oil-filled compartments, when they are provided, should be open during vacuum operations.

The nameplate will specify the vacuum as a safe limit. If it is necessary to fill units in the field apply the vacuum which is permitted by the nameplate for the length of time specified in Table 1, page 5.

The vacuum piping should be so related to the piping that liquid will not splash or spray into the vacuum line. It is advisable to provide a liquid trap in the vacuum line to protect the pump from the insulating liquid. The efficiency of most vacuum pumps is dependent upon the condition of

the pump oil. If the pump oil becomes cloudy from moisture or thins out because of insulating liquid contamination it should be changed.

## OIL, NITROGEN AND DRY AIR

**Oil.** The transformer oil must meet the requirements of Westinghouse Purchasing Department Specification 55822AG. Transformer oil is very sensitive to contamination, so that tanks, pumps, pipes and hoses in which the oil is shipped or handled must be clean and free from moisture and other contaminants. I.B. 45-063-100 contains instructions which must be followed in sampling, testing and handling the oil.

Tests shall be made of each shipping container (drum, tank truck or railroad car) of oil. Samples shall be drawn from the lowest point on the bottom of the container after the container has been filled. The electrical strength measured on samples taken after the oil has been received on site must be at least 30 KV. No free water shall be visually detectable on samples taken at the site. Power factor and water content should be measured on samples taken at the site if the laboratory facilities are available. Otherwise a certified test report furnished by the supplier for each shipping container of oil is acceptable. Power factor shall not exceed .05% and water content shall not exceed 35 ppm. No oil shall be used for filling a transformer until after the tests on the oil have been made with satisfactory results.

The temperature of the oil when it is added to the transformer during vacuum filling must be $10^{o}C$ or higher. If the transformer is to be opened after adding oil the oil temperature must be at least $10^{o}C$ higher than the dewpoint of the outside air.

Oil should be pumped into the top of the transformer through a blotter press or other conditioning equipment which will provide clean dry oil to the transformer. It is desirable, particularly in cold weather, to have heaters in the oil line so that the temperature of the oil going into the transformer can be as high as possible but do not exceed $90^{o}C$. The pumps, valves and piping should be arranged so that the oil is at a slight positive gauge pressure until it reaches a throttling valve just before the oil enters the transformer. The throttling valve and all connections between it and the transformer should be checked carefully for leaks. This is to prevent air and moisture from being drawn into the oil as it enters the transformer.

**Dry Air and Nitrogen.** When nitrogen is called for the nitrogen used should have a dewpoint not higher than $-50^{o}C$ ($-58^{o}F$), and total impurities not exceeding 0.1% by volume. Nitrogen can be obtained in high pressure steel cylinders, or in some locations in insulated low pressure containers in liquid form. In general, liquid nitrogen which will boil in the container to yield gaseous nitrogen, will have a lower dewpoint than gas in high pressure cylinders.

Dry air should also have a dewpoint of $-50^{o}C$ ($-58^{o}F$) or lower. It is usually available in cylinders from the same source which supply nitrogen. Air drying equipment is also available which is capable of producing dry air passing air through a dessicant bed to remove moisture.

When air or nitrogen are supplied from high pressure cylinders the proper regulating valve must be used for introducing the gas into the transformer tank. Cylinders should not be completely emptied, but should be returned to the supplier with at least 25 psi residual pressure.

## Memorandum

## Memorandum



Printed in U.S.A.

APPLICATION • INSTALLATION • INSPECTION

# INSTRUCTIONS

## GASKETS
### for Liquid Filled Transformers Tap Changers and Regulators

**GASKET APPLICATION**

| APPARATUS | GASKET MATERIAL | GASKET CEMENT | % GASKET COMPRESSION |
|---|---|---|---|
| Oil Insulated* Apparatus | Cork Neoprene PDS# 7249-11 or 45721AH (1) | #8440-4 | 43% |
| | Nitrile PDS# 12160-715.1 or 45351EH | None | 25% |
| Inerteen Insulated and Network Transformers | Cortite Nitrile PDS# 9950-3 or MC45711AB (1) | #7386-1 | 50% |
| "URS" and "URT" Tap Changers and Regulators | Cork Neoprene PDS# 7249-11 or 45721AH Flat Gaskets-No Gasket Stops | #8440-4 | 43% |
| | Dumbell Nitrile Section #258A460 or 45351EP | None | .... |

* Except "URS" and "URT" Tap Changers and Regulators.
(1)-Temporary shipping gaskets may be cork—for permanent application PDS # 7249-11, 45721AH, 9950-3 or MC45711AB should be used.

### GENERAL

The gaskets used on liquid filled transformers, tap changers and regulators are of materials which have proven suitable for that particular apparatus with which they are being used. Experience has shown that the use of the proper material used with the correctly associated apparatus and installed by a standard procedure assures a joint that will be leakproof.

### GASKET INSTALLATION

**A. Preparing Metal Surfaces.** Before applying a gasket to any metal surface care must be taken to assure that the mating surfaces are free of ice, dew condensation, oil, grease, rust or dirt by wiping dry. This can be done by using clean rags or any other method that will assure a dry surface. Rust should be removed by sanding or wire brushing. Thin uniform films of primer paint or gasket cement need not be removed. If the gasket is cut in the field, cut the gasket to conform to the surfaces to be sealed. Gasket thickness and percent compression must be in accordance with recommended practice. If the gasket is not a one-piece gasket, scarf the ends of the gasket so that the length of the overlap will be equal to four times the thickness of the gasket material. The mitering should be done with a fine toothed saw and a miter box to assure a clean uniform cut and to obtain full gasket thickness at the lap joint. A hand-type gasket cutter for keystone shaped interlocked joints is available for field work. These interlocked joints must be matched-cut by forming the joint properly and cutting both layers at the same time. Gasket cutting tool (up to 3 inches), style number 328B614G01. When ordering precut gaskets, give the complete nameplate reading of the transformer including serial number. Specify exact description of the gaskets required and give their location.

**B. Application of Permanent Gaskets when temperatures are above freezing.** It is recommended that both sides of the gasket be cemented to the gasket surfaces. Apply cement as follows:

#8440-4 Cement

1. Apply cement to both gasket and joint surfaces and let dry at least ten minutes but not more than 60 minutes.
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**Application of Permanent Gaskets when temperatures are below freezing.** To keep the gasket from getting too hard and to keep the cement fluid, the gaskets and cement should be kept at a minimum temperature of 35°F up to the time of actual application of cement and compression of gaskets. This will mean that the cement and gaskets will usually have to be kept warmer than this in freezing weather. It will not be necessary to coat the gasket groove with #8440-4 cement providing the gasket is assembled with the mating parts before the cement is completely set-up. By following these instructions you can be sure that the gasket will not be too hard to compress properly and the cement will adhere to the metal surfaces assuring an oil-tight seal.

#7386-1 Cement

1. Apply cement to both gasket and joint surfaces and let dry until "tacky".
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**C. Inspection Opening Gaskets.** Gaskets for inspection openings may be sealed on one side only to permit the removal of the inspection cover without destroying the gasket. It is recommended that the gasket be sealed to the stationary member of large openings and to the cover of small openings and load tap changer oil compartment doors. The gasket is sealed to one member by applying a uniform coating of gasket cement (for cork-neoprene use PDS#8440-4 S#1608171A; for "Cortite" or cork use PDS#7386-1 S#1150419) to one side of the gasket and to the surface to which the gasket is cemented. It is suggested that the surface of the gasket not cemented be coated with silicone lubricant M-5861-4 S#228A253H01, to prevent the vulcanizing of the gasket material to the steel plate. This will permit the removal of the cover without destroying the gasket.

For cemented surface follow cementing instructions above.

Prior to replacing a cover of an inspection opening, the gasket should be examined to make certain that it has not been damaged and that it has sufficient thickness to reseal the joint.

## MANHOLE COVER AND BUSHING FLANGE GASKETS

Gaskets for manhole covers should be sealed to the main cover boss opening to permit the removal of the manhole cover without destroying the gasket.

Bushing flange gaskets are sealed in permanently when the bushings are installed. Follow procedure for application of permanent gaskets.

*NOTE: It is very important that all openings in the transformer tank and tap changer be tightly closed before putting a unit into operation. This is necessary whether the unit is for indoor or outdoor operation. For all liquid filled tap changers and regulators; the bushing flanges, main cover, manhole covers, etc. must be oil and gas tight.*

## LEAKAGE TESTS

Liquid filled transformers should be tested for pressure tightness prior to putting in service. The permissible internal pressure that may be used can be determined from the nameplate on the transformer. Internal test pressures of ten pounds per square inch may be used to check the tightness of gasketed joints for transformers whose nameplates indicate that the transformer may be filled under complete vacuum. All other transformers should be tested with an internal pressure of five pounds per square inch.

The following precautions should be observed when making the pressure test:

1. Inertaire transformers;—Close the valves or disconnect the piping and plug the entrances into the tank before testing.

2. Open air breathers, dehydrating breathers, and breathing regulators: Close openings to this equipment before testing.

3. Mechanical relief device:—The relief device must be replaced by a steel plate when the test pressure is likely to exceed the tripping pressure of the relief device. For additional instructions, refer to the instruction leaflet for relief device.

4. Relief diaphragm:—A relief diaphragm must be replaced by a steel diaphragm when the test pressure is likely to exceed the rupturing pressure of the relief diaphragm. For additional instructions, refer to the instruction leaflet for relief diaphragm.

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SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.
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# Instructions for Standard Outside Finish, Oil Insulated Transformer Tanks



The STANDARD outside finish for Westinghouse oil insulated transformers is a three coat system that satisfactorily withstands widely diverse atmospheric conditions. The colors of the primer and finish coats are different so as to obtain a contrast between adjacent coats, thus insuring that each coat is continuous and of sufficient thickness.

The transformer tanks and accessories being constructed of steel, are normally susceptible to rusting. Therefore, to prevent rusting of exposed steel surfaces, give careful attention to the following steps:

1. All exposed steel surfaces must be thoroughly cleaned and prepared for the application of the protective coats of paint since the proper preparation of the surfaces to be finished is an important factor to securing a satisfactory and lasting finish.

Regardless of how good the paint may be, it will fail as a protector if applied over a wet, dirty, rusty, or greasy surface. Rust and scale will absorb and hold moisture. Therefore, in order to obtain a durable finish, it is absolutely essential that no moisture be sealed in by the application of paint. For large areas, a clean dry surface with sufficient roughness for good adhesion of the priming coat can be obtained by shot or sand blasting the exposed surfaces of the transformer tank.

2. The careful application of a high grade durable quality paint.

The factors that determine the quality of any paint are the pigment and vehicle. The pigment gives the color and body of the paint and the vehicle holds the pigment particles in place and forms a continuous film. Although attention is generally centered upon the selection of the pigment, tests show that the vehicle of a paint is the first of these two components to disintegrate. Therefore, a paint of high quality should be used to obtain a satisfactory finish.

## STANDARD FINISH

Tank. The Westinghouse standard finish for power transformer tanks is essentially a three-coat system.

The prime coat (M#32230EA) is composed of an alkyd type vehicle and pigments, primarily zinc chromate and iron oxide.

The two finish coats (M#32220CB) are composed of resins and pigments to withstand the elements and to provide good appearance when new, and after weathering has taken place. The finish coat conforms to NEMA standards (ASA#24 color).

Radiators. As a base for the paint, radiators are chemically cleaned and phosphatized. The standard finish for radiators is a three-coat system using high bake enamels.

The prime coat (M# 32232AR) is composed of an epoxy vehicle and pigments, primarily zinc chromate and iron oxide.

The intermediate and finish coat (M# 32224AX) consist of a high grade alkyd amine vehicle with the necessary pigmentation to withstand the elements.

Both the prime and the two finish coats require high bake temperatures for full cure. See Application Data.

## APPLICATION DATA

General. All four of these paints can be applied satisfactorily by flowing, dipping, spraying or brushing. For brush work, all paints are thinned sparingly; for spray work, a 5 to 6 parts paint to 1 part thinner, by volume, is adequate.

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Tank. For thinning primer M#32230EA and finish coat M#32220CB, a good grade V. M. & P. naptha is satisfactory.

The primer and finish coats may be air dried or force dried; air drying will require 8 to 12 hours depending on atmospheric conditions. For force drying a schedule of 1 to 2 hours at 125° - 135°C is recommended.

Radiators. For thinning primer M#32232AR and finish coats M#32224AX, Solvesso 150 is preferred, but toluol or xylol will prove adequate.

The primer and finish coats are strictly high baking materials. Westinghouse flows all coats and force dries and/or bakes the coatings during normal manufacturing processes. For baking, a metal temperature of 155°C minimum for 30 minutes is recommended.

Aerosol paint dispensers (12 oz.) are available for small repair jobs on tanks and radiators in the shop or field and are identified as follows:

| | |
|---|---|
| Prime Coat (M#32230EA) | Style No. 1772041 |
| Finish Coat (M#32220CB) | Style No. 1772043 |

Larger quantities of Westinghouse paints can be obtained through the nearest Westinghouse Sales Office.

IMPORTANT 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 scraper or sandpaper, applying a coat of primer paint and allow proper drying time, then apply a coat of finish paint.

NOTE For small marred spots which do not penetrate the paint film to the parent metal, only the finish paint is necessary. Due to the indefinite life of the primer, the finish paint should be applied as soon as possible.

# INSTRUCTIONS

## CLEANING TRANSFORMER INSULATION

There are times when it may become necessary to clean transformer insulation because of the accumulation of dust, grease, sludge or carbon deposits. The method for cleaning varies with the type of transformers.

### DRY-TYPE TRANSFORMERS

Dust, free of oil or grease, may be removed by wiping with a clean dry rag or by using a vacuum cleaner equipped with a brush attachment. The vacuum cleaner is preferred for large areas. Dust may be blown from inaccessible parts, but any dust removed by blowing is scattered and much of it will settle on other parts from which it must be removed as outlined above. The air must contain no moisture and care must be observed so that the insulation materials are not damaged by excessive air velocity.

Should grease or oil get upon the insulation it may be removed by wiping dry with a clean dry cloth.

Loose carbon deposits may be removed by brushing and/or wiping with clean dry cloths. Defective insulation should be replaced.

### OIL-FILLED TRANSFORMERS

Loose coatings of sludge and dirt may be removed by wiping with cloths saturated with transformer oil. Tightly adhering or heavy coatings of sludge may require a light brushing with a bristle brush, followed by a wash with transformer oil.

Sludge, dirt and oil-carbon deposits may often be effectively removed by spraying clean, dry, transformer oil upon and around the insulation with sufficient velocity to thoroughly wash and clean it. An air-ejector type nozzle should be used. Defective insulation should be replaced.

**Important:** Do not use knives, screw drivers or other sharp objects to clean coils since the use of these objects may cut the insulation.

### INERTEEN-FILLED TRANSFORMERS

Normally, the cleaning of insulation is not necessary for Inerteen transformers because Inerteen does not sludge. However, should it be necessary to remove a deposit of dirt, it may be done by wiping with a cloth saturated with clean Inerteen or trichlorbenzene.

When arcing occurs in Inerteen, the insulation is attacked by the products of decomposition of the Inerteen and usually requires replacing. The products of decomposition of the Inerteen now used in transformers have less effect on insulation than those from the earlier types of Inerteens. Hence it is more likely that the insulation in these transformers, not affected by direct arcing, may be used again.

For precautions in handling Inerteen refer to instruction book on Inerteen Transformers.

**Important:** Carbon tetrachloride should never be used for cleaning the insulation of either liquid filled or dry type transformers because it is nearly impossible to remove all of the carbon tetrachloride used for cleaning purposes, and during the natural operation of the transformers, the remaining carbon tetrachloride will form hydrochloric acid which will cause corrosion of metal parts and detrimentally affect the insulation.

This general procedure is not to be followed when specific instructions accompany the apparatus.

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

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# Instructions for Repairing Tank Leaks



This instruction leaflet is intended to give general instructions concerning recommended practices for repairing a weld leak in power transformers or their auxiliaries. Variations of these instructions may be desirable for special repair tasks, but normally the weld leak may be successfully sealed if these instructions are followed.

## TRANSFORMER CASES AND FITTINGS

Transformer cases and their fittings are fabricated from 3/16" to 1/2" thick welding quality low carbon steel, which are joined by manual, semi-automatic and automatic welding, using a manual shielded arc, submerged arc and inert arc process.

To repair a weld leak in a case seam or around one of the fittings the following is recommended:

1. De-energize the transformer. Check the liquid level in relation to the area to be welded. It should be 4" or more above the area to be welded. Should the area to be welded be above the liquid level or if the liquid has been removed from the case, blanket the transformer with dry nitrogen.

2. If the liquid has not been removed, pull a vacuum of several pounds per square inch above the liquid to stop the liquid leak. This may be done with a vacuum pump or by sealing all fittings on the case and draining sufficient oil to obtain the necessary vacuum.

**NOTE: Vacuum is not always required, especially when a sweating leak is to be repaired and the case wall is relatively thick.**

3. Peen the weld leak closed, if possible, with the ball end of a ball-peen hammer or with a blunt or round-nosed chisel.

4. Grind or scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine.

5. Select a 1/8" diameter all purpose, coated electrode, American Welding Society type E-6012 (Westinghouse type FP). Either a-c or d-c welding current may be used. When d-c current is used, straight polarity is preferred, that is the electrode is negative.

The welding machine is adjusted to supply the desired welding current. Some value between 115 to 125 amperes should be used, depending upon the welding operator's ability and the individual task at hand.

6. Apply a string bead sealing weld over the weld defect in a single, quick pass. This weld should be deposited horizontally or vertically depending upon circumstances. If the weld is deposited vertically, it is recommended that it be made downward to drive any liquid seepage ahead of the weld.

Successive beads are deposited adjacent and over the first sealing bead, or a single pass may be weaved across it to complete the weld. If the beads are deposited vertically, deposit these beads from the top down if any liquid seepage is present; otherwise they may be deposited upward if preferred. Remove the slag from the deposited weld before depositing each successive weld bead or pass.

Liquid interferes with the welding operation and the quality of the deposited metal. It should be wiped off with a dry cloth. All welds should be deposited in a sequence as above to prevent any liquid seepage interfering with the welding operation other than the final sealing at the lowest point of the weld leak.

7. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

Effective March, 1966 Supersedes I.L. 48-069-20C, November, 1962

Drain the liquid from the radiator and remove the radiator from transformer case.

2. Grind or scrape the paint from the area to be repaired. Also remove any liquid, dirt or foreign matter.

3. If the weld to be repaired is around the header flange use 1/8" diameter type E-6012 electrodes with current settings between 115 to 125 amperes. Weld horizontally around the flange.

4. A slightly reducing oxygen-acetylene welding flame is recommended for repairing a weld along the edge of an element, a weld joining the elements to each other, or a weld joining the elements to the header. The recommended procedure for repairing a leak along the edge of an element is outlined below:

a. Heat the full length of the seam with the oxy-acetylene torch to drive out all trapped oil.

b. Find the exact location of the leak by means of a suitable leak detector.

c. When the exact location of the leak has been determined, notch the edge of the element as shown in Figure 2 at points two to three inches on either side of the leak. These notches may be cut with a hack saw, a file, or a small grinder.

d. Start by filling one of the notches. Next, fill in the second notch. Finally fuse the edges of the element between the notches moving forward with a slightly weaving motion. Be sure to tie this weld into both filled notches. Use 1/16" soft iron gas welding rod as filler material.

Figure 3 shows the repaired element before touching up the repaired area.

5. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

6. After testing for leaks, reclean the area and apply touch-up paint as outlined in I.L. 48-069-15, "Standard Outside Finish for Westinghouse Oil Insulated Transformers."

7. Reinstall the radiator.

YUKON COOLERS

"Yukon" Coolers are formed by corrugating sections of the tank wall and are integral with the tank wall. The thickness of these coolers is usually 5/16" which corresponds to the wall thickness of network transformers on which they are primarily used. Since they are the same thickness as the tank wall and consist mostly of flat surfaces, the procedure for repairing weld leaks is the same as given under the information on the first page of this leaflet under "Transformer Cases and Fittings."

APPLICATION • INSTALLATION • INSPECTION

# INSTRUCTIONS

## GASKETS
### for Liquid Filled Transformers Tap Changers and Regulators

**GASKET APPLICATION**

| APPARATUS | GASKET MATERIAL | GASKET CEMENT | % GASKET COMPRESSION |
|---|---|---|---|
| Oil Insulated* Apparatus | Cork Neoprene PDS# 7249-11 or 45721AH (1) | #8440-4 | 43% |
| | Nitrile PDS# 12160-715.1 or 45351EH | None | 25% |
| Inerteen Insulated and Network Transformers | Cortite Nitrile PDS# 9950-3 or MC45711AB (1) | #7386-1 | 50% |
| "URS" and "URT" Tap Changers and Regulators | Cork Neoprene PDS# 7249-11 or 45721AH Flat Gaskets-No Gasket Stops | #8440-4 | 43% |
| | Dumbell Nitrile Section #258A460 or 45351EP | None | .... |

* Except "URS" and "URT" Tap Changers and Regulators.
(1)-Temporary shipping gaskets may be cork—for permanent application PDS #7249-11, 45721AH, 9950-3 or MC45711AB should be used.

### GENERAL

The gaskets used on liquid filled transformers, tap changers and regulators are of materials which have proven suitable for that particular apparatus with which they are being used. Experience has shown that the use of the proper material used with the correctly associated apparatus and installed by a standard procedure assures a joint that will be leakproof.

### GASKET INSTALLATION

**A. Preparing Metal Surfaces.** Before applying a gasket to any metal surface care must be taken to assure that the mating surfaces are free of ice, dew condensation, oil, grease, rust or dirt by wiping dry. This can be done by using clean rags or any other method that will assure a dry surface. Rust should be removed by sanding or wire brushing. Thin uniform films of primer paint or gasket cement need not be removed. If the gasket is cut in the field, cut the gasket to conform to the surfaces to be sealed. Gasket thickness and percent compression must be in accordance with recommended practice. If the gasket is not a one-piece gasket, scarf the ends of the gasket so that the length of the overlap will be equal to four times the thickness of the gasket material. The mitering should be done with a fine toothed saw and a miter box to assure a clean uniform cut and to obtain full gasket thickness at the lap joint. A hand-type gasket cutter for keystone shaped interlocked joints is available for field work. These interlocked joints must be matched-cut by forming the joint properly and cutting both layers at the same time. Gasket cutting tool (up to 3 inches), style number 328B614G01. When ordering precut gaskets, give the complete nameplate reading of the transformer including serial number. Specify exact description of the gaskets required and give their location.

**B. Application of Permanent Gaskets when temperatures are above freezing.** It is recommended that both sides of the gasket be cemented to the gasket surfaces. Apply cement as follows:

#8440-4 Cement

1. Apply cement to both gasket and joint surfaces and let dry at least ten minutes but not more than 60 minutes.
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**Application of Permanent Gaskets when temperatures are below freezing.** To keep the gasket from getting too hard and to keep the cement fluid, the gaskets and cement should be kept at a minimum temperature of 35°F up to the time of actual application of cement and compression of gaskets. This will mean that the cement and gaskets will usually have to be kept warmer than this in freezing weather. It will not be necessary to coat the gasket groove with #8440-4 cement providing the gasket is assembled with the mating parts before the cement is completely set-up. By following these instructions you can be sure that the gasket will not be too hard to compress properly and the cement will adhere to the metal surfaces assuring an oil-tight seal.

#7386-1 Cement

1. Apply cement to both gasket and joint surfaces and let dry until "tacky".
2. Assemble gasket and press firmly into place.
3. Coat other side as per (1).
4. Assemble joint.

**C. Inspection Opening Gaskets.** Gaskets for inspection openings may be sealed on one side only to permit the removal of the inspection cover without destroying the gasket. It is recommended that the gasket be sealed to the stationary member of large openings and to the cover of small openings and load tap changer oil compartment doors. The gasket is sealed to one member by applying a uniform coating of gasket cement (for cork-neoprene use PDS#8440-4 S#1608171A; for "Cortite" or cork use PDS#7386-1 S#1150419) to one side of the gasket and to the surface to which the gasket is cemented. It is suggested that the surface of the gasket not cemented be coated with silicone lubricant M-5861-4 S#228A253H01, to prevent the vulcanizing of the gasket material to the steel plate. This will permit the removal of the cover without destroying the gasket.

For cemented surface follow cementing instructions above.

Prior to replacing a cover of an inspection opening, the gasket should be examined to make certain that it has not been damaged and that it has sufficient thickness to reseal the joint.

## MANHOLE COVER AND BUSHING FLANGE GASKETS

Gaskets for manhole covers should be sealed to the main cover boss opening to permit the removal of the manhole cover without destroying the gasket.

Bushing flange gaskets are sealed in permanently when the bushings are installed. Follow procedure for application of permanent gaskets.

*NOTE: It is very important that all openings in the transformer tank and tap changer be tightly closed before putting a unit into operation. This is necessary whether the unit is for indoor or outdoor operation. For all liquid filled tap changers and regulators; the bushing flanges, main cover, manhole covers, etc. must be oil and gas tight.*

## LEAKAGE TESTS

Liquid filled transformers should be tested for pressure tightness prior to putting in service. The permissible internal pressure that may be used can be determined from the nameplate on the transformer. Internal test pressures of ten pounds per square inch may be used to check the tightness of gasketed joints for transformers whose nameplates indicate that the transformer may be filled under complete vacuum. All other transformers should be tested with an internal pressure of five pounds per square inch.

The following precautions should be observed when making the pressure test:

1. Inertaire transformers;—Close the valves or disconnect the piping and plug the entrances into the tank before testing.

2. Open air breathers, dehydrating breathers, and breathing regulators: Close openings to this equipment before testing.

3. Mechanical relief device:—The relief device must be replaced by a steel plate when the test pressure is likely to exceed the tripping pressure of the relief device. For additional instructions, refer to the instruction leaflet for relief device.

4. Relief diaphragm:—A relief diaphragm must be replaced by a steel diaphragm when the test pressure is likely to exceed the rupturing pressure of the relief diaphragm. For additional instructions, refer to the instruction leaflet for relief diaphragm.

WESTINGHOUSE ELECTRIC CORPORATION
SHARON PLANT • TRANSFORMER DIVISION • SHARON, PA.
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# Instructions for Standard Outside Finish, Oil Insulated Transformer Tanks

I. L. 48-069-15A

The STANDARD outside finish for Westinghouse oil insulated transformers is a three coat system that satisfactorily withstands widely diverse atmospheric conditions. The colors of the primer and finish coats are different so as to obtain a contrast between adjacent coats, thus insuring that each coat is continuous and of sufficient thickness.

The transformer tanks and accessories being constructed of steel, are normally susceptible to rusting. Therefore, to prevent rusting of exposed steel surfaces, give careful attention to the following steps:

1. All exposed steel surfaces must be thoroughly cleaned and prepared for the application of the protective coats of paint since the proper preparation of the surfaces to be finished is an important factor to securing a satisfactory and lasting finish.

Regardless of how good the paint may be, it will fail as a protector if applied over a wet, dirty, rusty, or greasy surface. Rust and scale will absorb and hold moisture. Therefore, in order to obtain a durable finish, it is absolutely essential that no moisture be sealed in by the application of paint. For large areas, a clean dry surface with sufficient roughness for good adhesion of the priming coat can be obtained by shot or sand blasting the exposed surfaces of the transformer tank.

2. The careful application of a high grade durable quality paint.

The factors that determine the quality of any paint are the pigment and vehicle. The pigment gives the color and body of the paint and the vehicle holds the pigment particles in place and forms a continuous film. Although attention is generally centered upon the selection of the pigment, tests show that the vehicle of a paint is the first of these two components to disintegrate. Therefore, a paint of high quality should be used to obtain a satisfactory finish.

## STANDARD FINISH

Tank. The Westinghouse standard finish for power transformer tanks is essentially a three-coat system.

The prime coat (M#32230EA) is composed of an alkyd type vehicle and pigments, primarily zinc chromate and iron oxide.

The two finish coats (M#32220CB) are composed of resins and pigments to withstand the elements and to provide good appearance when new, and after weathering has taken place. The finish coat conforms to NEMA standards (ASA#24 color).

Radiators. As a base for the paint, radiators are chemically cleaned and phosphatized. The standard finish for radiators is a three-coat system using high bake enamels.

The prime coat (M# 32232AR) is composed of an epoxy vehicle and pigments, primarily zinc chromate and iron oxide.

The intermediate and finish coat (M# 32224AX) consist of a high grade alkyd amine vehicle with the necessary pigmentation to withstand the elements.

Both the prime and the two finish coats require high bake temperatures for full cure. See Application Data.

## APPLICATION DATA

General. All four of these paints can be applied satisfactorily by flowing, dipping, spraying or brushing. For brush work, all paints are thinned sparingly; for spray work, a 5 to 6 parts paint to 1 part thinner, by volume, is adequate.

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Tank. For thinning primer M#32230EA and finish coat M#32220CB, a good grade V. M. & P. naptha is satisfactory.

The primer and finish coats may be air dried or force dried; air drying will require 8 to 12 hours depending on atmospheric conditions. For force drying a schedule of 1 to 2 hours at 125° - 135°C is recommended.

Radiators. For thinning primer M#32232AR and finish coats M#32224AX, Solvesso 150 is preferred, but toluol or xylol will prove adequate.

The primer and finish coats are strictly high baking materials. Westinghouse flows all coats and force dries and/or bakes the coatings during normal manufacturing processes. For baking, a metal temperature of 155°C minimum for 30 minutes is recommended.

Aerosol paint dispensers (12 oz.) are available for small repair jobs on tanks and radiators in the shop or field and are identified as follows:

| | |
|---|---|
| Prime Coat (M#32230EA) | Style No. 1772041 |
| Finish Coat (M#32220CB) | Style No. 1772043 |

Larger quantities of Westinghouse paints can be obtained through the nearest Westinghouse Sales Office.

IMPORTANT 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 scraper or sandpaper, applying a coat of primer paint and allow proper drying time, then apply a coat of finish paint.

NOTE For small marred spots which do not penetrate the paint film to the parent metal, only the finish paint is necessary. Due to the indefinite life of the primer, the finish paint should be applied as soon as possible.

**Westinghouse Electric Corporation**
Power Transformer Division, Sharon, Pa.
Printed in U. S. A. (E.P.)

# INSTRUCTIONS

## CLEANING TRANSFORMER INSULATION

There are times when it may become necessary to clean transformer insulation because of the accumulation of dust, grease, sludge or carbon deposits. The method for cleaning varies with the type of transformers.

### DRY-TYPE TRANSFORMERS

Dust, free of oil or grease, may be removed by wiping with a clean dry rag or by using a vacuum cleaner equipped with a brush attachment. The vacuum cleaner is preferred for large areas. Dust may be blown from inaccessible parts, but any dust removed by blowing is scattered and much of it will settle on other parts from which it must be removed as outlined above. The air must contain no moisture and care must be observed so that the insulation materials are not damaged by excessive air velocity.

Should grease or oil get upon the insulation it may be removed by wiping dry with a clean dry cloth.

Loose carbon deposits may be removed by brushing and/or wiping with clean dry cloths. Defective insulation should be replaced.

### OIL-FILLED TRANSFORMERS

Loose coatings of sludge and dirt may be removed by wiping with cloths saturated with transformer oil. Tightly adhering or heavy coatings of sludge may require a light brushing with a bristle brush, followed by a wash with transformer oil.

Sludge, dirt and oil-carbon deposits may often be effectively removed by spraying clean, dry, transformer oil upon and around the insulation with sufficient velocity to thoroughly wash and clean it. An air-ejector type nozzle should be used. Defective insulation should be replaced.

**Important: Do not use knives, screw drivers or other sharp objects to clean coils since the use of these objects may cut the insulation.**

### INERTEEN-FILLED TRANSFORMERS

Normally, the cleaning of insulation is not necessary for Inerteen transformers because Inerteen does not sludge. However, should it be necessary to remove a deposit of dirt, it may be done by wiping with a cloth saturated with clean Inerteen or trichlorbenzene.

When arcing occurs in Inerteen, the insulation is attacked by the products of decomposition of the Inerteen and usually requires replacing. The products of decomposition of the Inerteen now used in transformers have less effect on insulation than those from the earlier types of Inerteens. Hence it is more likely that the insulation in these transformers, not affected by direct arcing, may be used again.

For precautions in handling Inerteen refer to instruction book on Inerteen Transformers.

**Important: Carbon tetrachloride should never be used for cleaning the insulation of either liquid filled or dry type transformers because it is nearly impossible to remove all of the carbon tetrachloride used for cleaning purposes, and during the natural operation of the transformers, the remaining carbon tetrachloride will form hydrochloric acid which will cause corrosion of metal parts and detrimentally affect the insulation.**

This general procedure is not to be followed when specific instructions accompany the apparatus.

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

SUPERSEDES I.L. 47-600-23A
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NOVEMBER, 1964

# Instructions for Repairing Tank Leaks



This instruction leaflet is intended to give general instructions concerning recommended practices for repairing a weld leak in power transformers or their auxiliaries. Variations of these instructions may be desirable for special repair tasks, but normally the weld leak may be successfully sealed if these instructions are followed.

## TRANSFORMER CASES AND FITTINGS

Transformer cases and their fittings are fabricated from 3/16" to 1/2" thick welding quality low carbon steel, which are joined by manual, semi-automatic and automatic welding, using a manual shielded arc, submerged arc and inert arc process.

To repair a weld leak in a case seam or around one of the fittings the following is recommended:

1. De-energize the transformer. Check the liquid level in relation to the area to be welded. It should be 4" or more above the area to be welded. Should the area to be welded be above the liquid level or if the liquid has been removed from the case, blanket the transformer with dry nitrogen.

2. If the liquid has not been removed, pull a vacuum of several pounds per square inch above the liquid to stop the liquid leak. This may be done with a vacuum pump or by sealing all fittings on the case and draining sufficient oil to obtain the necessary vacuum.

NOTE: Vacuum is not always required, especially when a sweating leak is to be repaired and the case wall is relatively thick.

3. Peen the weld leak closed, if possible, with the ball end of a ball-peen hammer or with a blunt or round-nosed chisel.

4. Grind or scrape the paint from the area to be welded and prepare a suitable point for attaching the ground lead to the arc welding machine.

5. Select a 1/8" diameter all purpose, coated electrode, American Welding Society type E-6012 (Westinghouse type FP). Either a-c or d-c welding current may be used. When d-c current is used, straight polarity is preferred, that is the electrode is negative.

The welding machine is adjusted to supply the desired welding current. Some value between 115 to 125 amperes should be used, depending upon the welding operator's ability and the individual task at hand.

6. Apply a string bead sealing weld over the weld defect in a single, quick pass. This weld should be deposited horizontally or vertically depending upon circumstances. If the weld is deposited vertically, it is recommended that it be made downward to drive any liquid seepage ahead of the weld.

Successive beads are deposited adjacent and over the first sealing bead, or a single pass may be weaved across it to complete the weld. If the beads are deposited vertically, deposit these beads from the top down if any liquid seepage is present; otherwise they may be deposited upward if preferred. Remove the slag from the deposited weld before depositing each successive weld bead or pass.

Liquid interferes with the welding operation and the quality of the deposited metal. It should be wiped off with a dry cloth. All welds should be deposited in a sequence as above to prevent any liquid seepage interfering with the welding operation other than the final sealing at the lowest point of the weld leak.

7. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

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Drain the liquid from the radiator and remove the radiator from transformer case.

2. Grind or scrape the paint from the area to be repaired. Also remove any liquid, dirt or foreign matter.

3. If the weld to be repaired is around the header flange use 1/8" diameter type E-6012 electrodes with current settings between 115 to 125 amperes. Weld horizontally around the flange.

4. A slightly reducing oxygen-acetylene welding flame is recommended for repairing a weld along the edge of an element, a weld joining the elements to each other, or a weld joining the elements to the header. The recommended procedure for repairing a leak along the edge of an element is outlined below:

a. Heat the full length of the seam with the oxy-acetylene torch to drive out all trapped oil.

b. Find the exact location of the leak by means of a suitable leak detector.

c. When the exact location of the leak has been determined, notch the edge of the element as shown in Figure 2 at points two to three inches on either side of the leak. These notches may be cut with a hack saw, a file, or a small grinder.

d. Start by filling one of the notches. Next, fill in the second notch. Finally fuse the edges of the element between the notches moving forward with a slightly weaving motion. Be sure to tie this weld into both filled notches. Use 1/16" soft iron gas welding rod as filler material.

Figure 3 shows the repaired element before touching up the repaired area.

5. Clean the repaired area and check with a suitable leak detector to be sure the leak has been stopped.

6. After testing for leaks, reclean the area and apply touch-up paint as outlined in I.L. 48-069-15, "Standard Outside Finish for Westinghouse Oil Insulated Transformers."

7. Reinstall the radiator.

YUKON COOLERS

"Yukon" Coolers are formed by corrugating sections of the tank wall and are integral with the tank wall. The thickness of these coolers is usually 5/16" which corresponds to the wall thickness of network transformers on which they are primarily used. Since they are the same thickness as the tank wall and consist mostly of flat surfaces, the procedure for repairing weld leaks is the same as given under the information on the first page of this leaflet under "Transformer Cases and Fittings."



**Westinghouse Electric Corporation**
Power Transformer Division, Sharon, Pa.

Printed in U.S.A. (TP)

# Instructions for Shipment, Installation & Storage of Small Power Transformers

## South Boston Units

**Westinghouse Electric Corporation**
SMALL POWER TRANSFORMER DIVISION, SOUTH BOSTON, VIRGINIA
I.L. 48-069-40 Effective May, 1972

# Contents

## INTRODUCTION

This leaflet gives procedures to be followed from the time a transformer is received until it is energized. These instructions apply to transformers shipped from the Small Power Transformer Division at South Boston, Virginia. They do not necessarily apply to transformers shipped from other manufacturing locations.

## SHIPPING PRACTICES

Transformers are shipped from the South Boston Works as complete units ready to energize without opening the transformer tank where possible; that is, with bushings installed with insulating liquid to the correct liquid level, with thermometers, pressure gauges etc. installed on the tank. Some items are necessarily removed to either prevent damage during shipment or to meet shipping dimensional requirements. When items are removed for shipment they are specified on the outline drawing. Any external bracing required for shipment which must be removed during installation will be shown on outline or detail drawings and painted yellow.

Transformers will be shipped without liquid in dry nitrogen only when this is required by the customer's contract.

Unless otherwise specified by the customer all equipment will be shipped by motor truck. Impact recorders are not necessary and will not be used.

Some items manufactured at other factory locations will be shipped direct to the customers shipping locations. These items are shown on the outline drawing as "shipped direct."

## PRECAUTIONS

**Safety. Normal good safety practices must be followed during the inspection and installation of transformers. In addition, there are procedures that are more or less peculiar to transformers which should be followed for the protection of workmen and of the transformer.**

**The transformer tank must be grounded at all times. Windings and bushings must be grounded except when electrical tests are being made. All fluid handling equipment and vacuum pumps must also be grounded. This will reduce the possibility of static discharges.**

**Electrical tests must not be performed when vacuum is applied to the transformer if such test produces a potential of more than 125 volts anywhere in the transformer.**

**Fire extinguishers should be provided for emergency use. One should be available on top of the transformer when work is being done inside the tank. No smoking should be permitted on top of the transformer when any covers are opened or in the vicinity of the oil handling equipment. NOTE: It should be realized that the use of a fire extinguisher inside the transformer will usually severely damage or ruin the transformer insulation. $CO_2$ extinguishers cause the least damage.**

**Before removing any covers or fittings from the transformer make certain that there is zero gauge pressure in the tank and the fluid level is not above that particular opening.**

**Never allow anyone to enter the transformer tank unless an analysis of the air in the tank shows at least 18% oxygen. Whenever anyone is in the tank, a man should be stationed at the manhole outside the tank.**

**Lights must be explosion proof and have oil resistant cords.**

**Avoiding Transformer Damage.** Transformers are generally shipped sealed and ready for energizing without opening the tank. In cases where it is necessary to open the tank for changing terminal board connections or installing high voltage bushings extreme care is required to protect the insulation from damage. Internal parts are located to

provide the necessary electrical clearances and must not be bent or moved out of position. All contaminating materials must be kept out of the tank.

While the transformer is open no one should be permitted on top of the transformer until he has emptied all pockets, checked for loose objects elsewhere on his person, such as in pants cuffs, and has removed watches and rings.

Persons entering the transformer must not have loose dirt particles on their clothing. Clean cloth shoe covers or nitrile rubber overshoes must be worn by anyone entering the tank.

Never stand directly on any electrical insulation.

Clean drop cloths should be used under working areas in the transformer to prevent objects from dropping into the structure.

All tools must be accounted for. If possible, tools should have lines attached so that they cannot be lost.

One person should be responsible for policing the people and materials into and out of the tank and for making certain that nothing is left in the tank accidentally. This person should also be responsible for limiting the length of time the tank is left open as specified on page 3.

In the event of sudden weather changes, threatening rain or snow, provisions should be made for closing the tank quickly to protect the insulation.

If any object is dropped into the transformer and cannot be retrieved, a Westinghouse representative must be notified immediately.

Do not conduct vacuum operations when it is raining or while the transformer is unattended.

The use of pressure gauges containing mercury should be avoided unless an effective trap is placed between the gauge and the transformer because of the possibility of an accident resulting in mercury getting into the transformer. For measuring vacuum, **properly calibrated** thermo-couple gauges or aneroid absolute pressure gauges are preferred.

In most cases it is not necessary nor desirable to open the transformer tank. There are no internal braces to be removed.

The voltages of the high voltage circuit and the low voltage circuit must match the transformer voltages as shown on the nameplate. The tap changers must be set on the correct positions. The transformers must also be phased out correctly before closing the circuits. Energizing the transformer at the wrong voltage or out of phase may result in damage requiring complete rebuilding of the internal parts.

## RECEIVING INSPECTION

**Drawings and Documents.** Shipping papers, outline drawings, instruction leaflets and other pertinent documents furnished with the transformer must be available for use during the inspection.

**External Inspection.** External inspection prior to unloading the transformer should include all of the items in the check list below. Any external evidence of damage or evidence indicating the possibility of hidden damage must be reported to the carrier's representative and to a Westinghouse representative before unloading the transformer.

**Insulation Dryness.** Drying operations in the factory reduce the moisture content to a very low level. This dry condition should be maintained. The amount of moisture can be estimated by a dewpoint measurement for units shipped in nitrogen, or by measurement of insulation resistance or of insulation power factor for units shipped in liquid if there is any reason to question the dryness.

The dewpoint can be measured using a dry ice dewpoint apparatus, or with a Panametrics Alumi-

**CHECK LIST**

**External Inspection of Transformer**

**Blocking and Tie Rods**

1. Are all tie rods or chains undamaged and nuts tight.
2. Is all blocking tight and in good conditions?
3. Is there any evidence of load shifting in transit?

**Transformer Tank and Fittings**

4. Are there indications of external damage?
5. Is the paint finish damaged?
6. Are all fittings which were shipped attached still in place and undamaged?
7. Is there any evidence of liquid leakage?

**Bushings (when shipped attached)**

8. Are any porcelains chipped or otherwise damaged?

num Oxide Hygrometer (Panametrics, Inc., 221 Crescent Street, Waltham, Massachusetts 02154). An estimate must be made of the average temperature of the transformer insulation. This will require some judgment, depending upon the weather conditions and exposure of the transformer to wind and direct sun. The gas in the transformer should be at a slight positive gauge pressure, preferably not higher than 2 psi gauge when the dewpoint is measured.

Insulation resistance and power factor measurements should be made and compared with measurements made at the factory.

Factory measurements of insulation and power factor are obtained with the unit liquid filled. Therefore, direct comparison of these quantities when measured with gas instead of liquid in the unit is not possible.

If there are indications of moisture in the insulation the factory should be contacted immediately for confirmation of the analysis of the measurements, and for recommendations for the drying procedure to be followed.

If the transformer is opened, the time the transformer is open should not exceed 2 hours after which the transformer should be sealed.

It may be necessary to remove some liquid from liquid-filled units. If this is done, refilling of the transformer must be done as specified in FINAL FILLING, page 6.

**Electrical Tests.** If any damage is suspected, the following tests must be made:

a. A ratio test should be made on all windings and taps. If any measurement is off ratio by more than 0.5%, resistance measurements should be made of the winding in question and compared with factory test values.

b. Insulation resistance of each winding to all other windings and ground and from all windings to ground should be made with the windings under liquid. These readings should be comparable with measurements made at the factory.

**Detail Parts.** All detail parts should be checked against the packing list to make certain that there are no shortages. The crates and boxes should be carefully examined for evidence of damage.

In making examinations of any parts or crates for shipping damage, check carefully for evidence of the entrance of moisture and for damage to the moisture barriers or waterproof wrappings.

Accessories and detail parts should be placed in a location which will minimize exposure to weather and the possibility of damage or loss. If

the transformer is not to be installed immediately, the parts must be stored in accordance with Storage of Unmounted Accessories.

**Paint Finish.** Inspect the paint finish on the main transformer tank and on all painted detail parts for damaged areas. Apply touchup paint to these areas.

## HANDLING

Transformers must be handled in the normal upright position unless instructions have been received to the contrary.

Lifting hooks or eyes are provided for crane lifting. When the transformer is lifted, all hooks or eyes must be used. Similarly, jacking areas are provided for lifting the transformer with jacks. All such areas must be used when the transformer is to be jacked.

When the transformer has a removable top section or a bolted main cover, the top section or cover must be bolted in place when lifting.

Check the outline drawing for any required special equipment or procedures to be used in lifting.

Never attempt to lift the transformer by using cranes or jacks on any part of the transformer other than the fittings or jacking areas provided for this purpose.

## STORAGE PRIOR TO ENERGIZING

**Temporary Storage. (Up to 3 months) Without Liquid in Nitrogen.** If the transformer cannot be installed immediately upon arrival, and liquid filling is impractical, it is permissible to store the transformer in nitrogen for up to three months, after date of arrival at the site.

The storage of transformers in nitrogen requires positive assurance that the gas pressure is continuously maintained. The best method of accomplishing this is by use of Inertaire equipment. If the transformer is not equipped for Inertaire, temporary pipe connections can be made using the upper filter press or vacuum filling connections. The Electric Service Department can obtain upon request the necessary Inertaire equipment for proper storage.

The transformer must be placed on a solid level foundation in the storage area. The Inertaire equipment must be installed within one week after the transformer has been delivered. Ground the tank and any bushings that are mounted.

After installing the Inertaire equipment with a full cylinder of dry nitrogen pressure test the transformer for four hours at three psi gauge pressure. Check the tank for leaks with soap suds. After pressure testing, set the Inertaire equipment for normal operation. A positive nitrogen pressure must be maintained at all times.

Transformer gas pressure and cylinder pressure should be recorded every day for the first two weeks. These readings should preferably be taken at approximately the same time every day and the time and temperature also noted on the log. After two weeks of daily logging with stable conditions the frequency of pressure readings may be reduced to once a week. An accurate log is important as it may be the determining factor in any decision that may have to be made on further drying of the windings. Follow the instructions for the particular Inertaire equipment used or information provided by the Engineering and Service Departments. Transformers should not be stored more than three months without being filled with liquid.

To place the unit in service, the same procedure must be followed as though the transformer had just been received. When vacuum filling with liquid the length of the vacuum period prior to liquid filling specified in Table I, page 5, shall be increased by four hours.

**Storage in Liquid.** If the transformer is to be stored for more than three months it should be filled with liquid. The transformer will then be

| TABLE 1 – VACUUM TREATMENT AND LIQUID FILLING | | |
|---|---|---|
| CONDITION | 15 P.S.I. OR FULL VACUUM TANKS | |
| | ABSOLUTE PRESSURE IN TANK TORR | VACUUM HOLDING TIME HOURS |
| Before Filling | 5 Maximum | 4 |
| During Filling | 6 Maximum | - |
| After Filling | 5 Maximum | 2 |
| | 8 P.S.I. TANKS | |
| Before Filling | 347 Minimum | 4 |
| During Filling | 347 Minimum | - |
| After Filling | 347 Minimum | 2 |
| | 5 P.S.I. TANKS | |
| Before Filling | 502 Minimum | 4 |
| During Filling | 502 Minimum | - |
| After Filling | 502 Minimum | 2 |

NOTE: 1 TORR = 1 mm Hg = .0193 P.S.I.

CAUTION: Where "MINIMUM" is specified lower pressures may result in tank damage or permanent deformation with serious damage to internal parts.

ready for service at any time providing it receives the same inspection and maintenance as a transformer in service.

At the end of the storage period samples of liquid should be drawn from the transformer and tested for electrical strength and water content. Make megger and power factor tests on each winding to other windings and to ground and from all windings to ground and compare with factory test values. If all test results are satisfactory, completely assembled units may be energized. Installation of other transformers should be completed as specified.

**Separate Storage of Unmounted Accessories.** When accessories are not mounted immediately after the transformer is received they must be given care to protect them from damage or loss during storage. The following general instructions and the more detailed instructions given in instruction leaflets for the accessories, when furnished, must be followed. In the event of conflict between this leaflet and the instruction leaflet for the individual accessory the latter shall take precedence.

**Bushings.** The bushings when shipped detail are crated or boxed. The lower end of the bushing is covered with a plastic bag to keep it clean and dry. The plastic bags on Type S and Type OS bushings contain a bag of silica gel. Examine for signs of moisture inside the plastic bags. If the bags are damaged replace the bags and the silica gel before storing.

It is best to store condenser bushings in a clean, dry place indoors in their shipping crates. Type "O" bushings must be stored with the top end elevated at an angle of at least 20° from the horizontal above the bottom end. They may be stored in the shipping box.

**Detail Box.** Store the box, containing details as shipped, indoors and in a dry place. The box contains Inertaire connections, gaskets, paint, gasket cement, sudden pressure relay, etc., as specified on the detail packing list.

**Inertaire.** The Inertaire cabinet is shipped on the transformer when shipping clearances permit. The pressure gauge and reducing valves (one assembly), three-way valve, sump, and plastic hoses are assembled and in the cabinet. Flexible tubing for connecting the nitrogen tank to the cabinet is shipped in the detail box. The nitrogen tank must be assembled to the transformer before the transformer is stored or any work is started.

Indoor storage is required for all items marked FRAGILE and for porcelain stored more than one month.

**Drawings and Other Documents.** The outline drawing for the transformer must be checked carefully. The circuit diagram and nameplate should also be observed closely in planning and performance of all work. Instruction leaflets for accessory equipment must be followed.

## FINAL FILLING OF TRANSFORMERS SHIPPED IN NITROGEN

The temperature of the core and coils must be above 0°C during the vacuum and vacuum filling operations.

**Vacuum Equipment and Procedures.** In order to attain the vacuum levels specified and to maintain these levels during oil filling a good vacuum pump of adequate capacity will be needed. A 100 cfm pump will be adequate. The pumps should be capable of attaining a blankoff pressure of .02 Torr or less for 15 psi or full vacuum tanks.

Connections from the pump to the transformer tank should be as short and as large in diameter as possible. The line should be at least 1 inch in diameter, and preferably larger. There should be no low spots in the vacuum line in which liquid can collect.

The pressure in the tank during vacuum operations should be measured through a connection to the top section of the tank above the liquid level. Do not use pressure measurements at locations other than the tank itself. For measuring the pressure in the tank a properly calibrated aneroid gauge or thermocouple gauge is recommended. Use mercury gauges only if a trap is provided which will prevent mercury from entering the transformer.

It is important that the entire system be as free from leaks as possible. Otherwise it may be difficult or impossible to attain the specified vacuum levels. Also, any leaks will permit moist air or water to be drawn into the transformer. If a high capacity pump is used it is especially important to eliminate leaks so that moisture drawn into the system is minimized.

Openings for relief devices and other accessories must be sealed in accordance with instructions furnished for the particular accessory in order to prevent air from entering the transformer during vacuum operations. Valves in pipe connections between the main tank and oil-filled compartments, when they are provided, should be open during vacuum operations.

The nameplate will specify the vacuum as a safe limit. If it is necessary to fill units in the field apply the vacuum which is permitted by the nameplate for the length of time specified in Table 1, page 5.

The vacuum piping should be so related to the piping that liquid will not splash or spray into the vacuum line. It is advisable to provide a liquid trap in the vacuum line to protect the pump from the insulating liquid. The efficiency of most vacuum pumps is dependent upon the condition of

the pump oil. If the pump oil becomes cloudy from moisture or thins out because of insulating liquid contamination it should be changed.

## OIL, NITROGEN AND DRY AIR

**Oil.** The transformer oil must meet the requirements of Westinghouse Purchasing Department Specification 55822AG. Transformer oil is very sensitive to contamination, so that tanks, pumps, pipes and hoses in which the oil is shipped or handled must be clean and free from moisture and other contaminants. I.B. 45-063-100 contains instructions which must be followed in sampling, testing and handling the oil.

Tests shall be made of each shipping container (drum, tank truck or railroad car) of oil. Samples shall be drawn from the lowest point on the bottom of the container after the container has been filled. The electrical strength measured on samples taken after the oil has been received on site must be at least 30 KV. No free water shall be visually detectable on samples taken at the site. Power factor and water content should be measured on samples taken at the site if the laboratory facilities are available. Otherwise a certified test report furnished by the supplier for each shipping container of oil is acceptable. Power factor shall not exceed .05% and water content shall not exceed 35 ppm. No oil shall be used for filling a transformer until after the tests on the oil have been made with satisfactory results.

The temperature of the oil when it is added to the transformer during vacuum filling must be $10^{o}C$ or higher. If the transformer is to be opened after adding oil the oil temperature must be at least $10^{o}C$ higher than the dewpoint of the outside air.

Oil should be pumped into the top of the transformer through a blotter press or other conditioning equipment which will provide clean dry oil to the transformer. It is desirable, particularly in cold weather, to have heaters in the oil line so that the temperature of the oil going into the transformer can be as high as possible but do not exceed $90^{o}C$. The pumps, valves and piping should be arranged so that the oil is at a slight positive gauge pressure until it reaches a throttling valve just before the oil enters the transformer. The throttling valve and all connections between it and the transformer should be checked carefully for leaks. This is to prevent air and moisture from being drawn into the oil as it enters the transformer.

**Dry Air and Nitrogen.** When nitrogen is called for the nitrogen used should have a dewpoint not higher than $-50^{o}C$ ($-58^{o}F$), and total impurities not exceeding 0.1% by volume. Nitrogen can be obtained in high pressure steel cylinders, or in some locations in insulated low pressure containers in liquid form. In general, liquid nitrogen which will boil in the container to yield gaseous nitrogen, will have a lower dewpoint than gas in high pressure cylinders.

Dry air should also have a dewpoint of $-50^{o}C$ ($-58^{o}F$) or lower. It is usually available in cylinders from the same source which supply nitrogen. Air drying equipment is also available which is capable of producing dry air passing air through a dessicant bed to remove moisture.

When air or nitrogen are supplied from high pressure cylinders the proper regulating valve must be used for introducing the gas into the transformer tank. Cylinders should not be completely emptied, but should be returned to the supplier with at least 25 psi residual pressure.

## Memorandum

## Memorandum



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