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TRANSFORMER INSTRUCTION MANUAL INTRODUCTION

This manual has been prepared to provide the user with information on the recommended installation, operation, maintenance, and storage procedures for Siemens Transformadores, S.A de C.V.

The instructions contained in this manual describe minimum requirements **only**. Further additional instructions specific to the transformer you have purchased may be provided by Siemens Transformadores, S.A de C.V. and must be followed in order for the Siemens Transformadores, S.A de C.V. warranty to remain in effect.

This Instruction Manual must be made available at all times to those responsible for the installation, operation and maintenance of your Siemens Transformadores, S.A de C.V.

WARNING

This Equipment Should Be Installed, Operated And Maintained Only By Qualified Persons Thoroughly Familiar With The Equipment, Instruction Manuals And Drawings.

Failure To Store, Install, Operate, Maintain Or Protect The Equipment Properly Will Cause Personal Injury, Death Or Damage To The Equipment And Will Void Warranty.

Should further information be desired with respect to the proper installation operation, maintenance, and storage of your Siemens Transformadores, S.A de C.V. the matter should be referred to:

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DESCRIPTION $\approx$ OPERATION $\approx$ MAINTENANCE SAFETY INSTRUCTIONS

WARNING

SAFETY INFORMATION IN THIS LEAFLET AND IN THE INSTRUCTION MANUAL MUST BE FOLLOWED DURING THE HANDLING, INSTALLATION, COMMISSIONING, OPERATION AND MAINTENANCE OF THIS TRANSFORMER. READ THE ENTIRE INSTRUCTION BOOK CAREFULLY BEFORE ATTEMPTING TO HANDLE, INSTALL OR ENERGIZE THE TRANSFORMER. FAILURE TO FOLLOW THESE PRECAUTIONS MAY RESULT IN EQUIPMENT DAMAGE, SEVERE PERSONAL INJURY OR DEATH.

This Instruction Manual **must** be made available at **all times** to those responsible for the installation, operation and maintenance of the transformer.

Minimum safety procedures are described in the manual and leaflets and **must be followed**. Additionally, all applicable safety procedures such as government requirements, regional and local safety requirements, safe working practices, and good judgment must be used by personnel when installing, operating, and / or maintaining such equipment.

Normal good safety practices must be followed during inspection, installation, operation, or maintenance of transformers. In addition, there are procedures that are peculiar to transformers which must be followed for the protection of the workers and the transformer. Failure to follow **safety instructions** could result in severe personal injury, death, and / or product or property damage.

The installation, operation and maintenance of a transformer presents potential unsafe conditions, including but not limited to, the following:

Heavy components;

Lethal voltages;

Unsafe atmospheres;

High pressures;

Improper tap changer operation;

Improper tap changer operation;

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Safety, as defined in this Instruction Manual involves two conditions:

- Personal injury or death.
- Product or property damage (includes damage to the transformer, other property, and reduced transformer life).

Safety notations are intended to alert personnel of possible personal injury, death or property damage. They have been inserted throughout the instructional text where they apply.

The safety notations are categorized in one of two hazard intensity levels which are defined as follows:

WARNING

- **WARNING** - hazard or unsafe practice which could result in severe personal injury, death, or property damage.

CAUTION

- **CAUTION** - hazard or unsafe practice which could result in minor personal injury, or property damage.

For the workers protection, the following list of safety precautions must be followed during handling, installation, and maintenance of power transformers.

- SUPPORTS FOR CLIMBING

- External valves, piping, lightning arrester brackets, and miscellaneous fittings must not be used for climbing or support. They will not support a human's weight and are not safe for climbing.

- LIFTING AND JACKING

- Lifting and jacking must be done using the proper lifting eyes and jacking pads. Many of the eyes and surfaces are not suitable for lifting or jacking and will not support the weight of the transformer. Refer to the transformer outline drawing supplied with the unit for correct location for these operations. Injury to personnel and damage to the transformer can result if improper fittings are used.

- GROUNDING

- The transformer tank must be grounded at all times.
- Windings must be grounded except when electrical tests are being made or transformers are being operated.
- All bushings must be grounded after installation except during tests and when the transformer is in operation.
- All oil handling equipment and vacuum pumps must be grounded. Maintain equipment grounds for a minimum of one hour after oil filling.
- All test equipment must be properly grounded.
- Disregarding any of the above can result in static discharges injuring personnel and damaging the transformer.

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- TRANSFORMER INTERNAL PRESSURE

- Do not open any covers or fittings unless zero gauge pressure exists inside the unit. Failure to relieve the pressure could cause the part being removed to become a hazardous flying object. Always relieve internal pressures slowly through valves.-

- TRANSFORMER INTERNAL ATMOSPHERE

- Do not enter the transformer or breathe the internal atmosphere unless the oxygen content of the gas inside the transformer is at least 19.5%, carbon monoxide content does not exceed 35% and combustible gases must be less than 10%.
- Oxygen contents less than this can cause drowsiness, injury or death. Transformers shipped gas filled are not safe to enter. Always check oxygen content.
- Once a breathable atmosphere has been established, a continuous supply of known breathable dry air must be provided. The supply should be a minimum of 100 cubic feet (3,000 litres) per man per hour while working inside. As dry air, it should have a dew point no higher than -50°C (-60°C preferred). Do not bubble air through residual oil in the bottom of the tank as this will produce undesirable oil vapour.
- Whenever anyone is inside the tank, other personnel must be near the entry point at all times, and in communication with the person(s) inside and capable of rendering assistance as needed.
- Confined space entry rules must be followed.
- Use only explosion proof lights with oil resistant cords for internal inspections. (Max. 110 v)

- ELECTRICAL HAZARDS

- Every electrical circuit or component must be treated as energized and dangerous until positive proof is established that this is not the case.
- High turn ratios can transform very small input voltages into dangerous output voltages. Never touch any leads or bushings with test equipment energized.
- No electrical tests should be performed while a unit is under vacuum; flashovers can occur at very low voltages inside a transformer which is under vacuum.
- The jumpers or links which short the secondary terminals of current transformers must be left in place until permanent connections are made from the current transformer to its associated meter, relay or instrument.

- FIRE EXTINGUISHERS

- Fire extinguishers should be available for emergency use. One should be available on top of the transformer when work is being done inside the tank. Smoking must not be permitted on top or inside of the transformer.

NOTE: The use of a fire extinguisher inside the transformer will usually cause severe damage to or ruin the transformer insulation.

- CARE ON TRANSFORMER COVER

- Extreme caution must be used when walking on the cover of a transformer. The cover may become slippery due to an oil film or weather conditions.

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- BUSHINGS

- Caution must be used when grounding bushings because they may retain an electrical charge after transformers have been disconnected from external or test circuits.
 - Since transformers are capacitive devices and can pick up dangerous electro static charges, it is recommended that a "Hot Stick" be used to attach grounding connections to all bushings.
- Also, the following safety precautions **must** be observed while the transformer is in service.

- WORKING NEAR ENERGIZED TRANSFORMER

Never assume that the presence of a ladder implies that it is safe to climb. Never climb on any part of a transformer when it is energized. Injury or death can occur from electrical discharges.

- LIQUID LEVEL

- Do not open any valves or plugs on the transformer or any of its accessories while the transformer is energized because the liquid level could drop below the minimum level. (The gas or oil sampling valves are the only exception.) An internal flashover may occur if the oil is allowed to drop below the minimum oil level.

- CONTROL CIRCUITS

- The control circuits, inside and outside the control cabinet, utilize voltages that can be dangerous to personnel. Caution must be used when operating any of the switches or breakers. If work on the circuits is necessary, the power supply must be shut off.

- COOLING EQUIPMENT

- When the transformer is energized, the proper cooling equipment must be in operation. If not, dangerous pressures can occur inside the transformer and possibly result in injury to personnel.

- CURRENT TRANSFORMERS

- The secondaries of any current transformers not connected in auxiliary circuits must be shorted and grounded.

- ELECTRICAL GROUNDING

- The transformer tank must be solidly grounded.

- INTERNAL CONNECTIONS

- **Never operate an off circuit tap changer while the transformer is energized.**
- Do not attempt to change terminal board connections while the transformer is energized.

- WELDING ON TANK OR COMPONENTS

- Parts of the transformer or adjacent equipment which might be damaged by sparks or hot metal must be protected by fire resistant covering. (Be very careful of weld spatter on bushing insulators.)
- A transformer must be either a) properly gassed with an inert gas such as nitrogen or b) the part where the welding is taking place must be submerged in the transformer oil, during any burning or welding operations.
- Proper personal & safety equipment such as gloves, safety glasses, hearing protection, etc. must be worn by the operators. A suitable work platform is required.
- Correct fire extinguishers (CO₂) must be available at the job while burning or welding.
- A fire watch must be posted during burning or welding operations.

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DESCRIPTION – OPERATION - MAINTENANCE WARRANTY VALIDATION

To validate the warranty on this transformer, Siemens Transformadores S.A de C.V. requires the user to comply with the inspection and testing conditions stipulated in the Instruction Manual for receiving, installation, oil filling and commissioning of the transformer. These tests and inspections consist of, but are not limited to, the following:

Receiving:

Receive the transformer and perform the following inspections prior to unloading:

- ◆ Check impact recorder (if applicable).
- ◆ Check for external damage and state of tie down bolts, cables or rods.
- ◆ Check gas pressure, ambient temperature (liquid temperature gauge) and record readings. If a positive or negative pressure reading is obtained, the tank is probably free of leaks. If the gas in the tank is at atmospheric pressure, there is probably a leak in the tank.
- ◆ Megger core ground and record reading. Use a 500 or 1000 volt Megger. Any reading greater than 100 Megohms indicates proper core insulation.
- ◆ Check condition of boxes and components shipped separately. Verify parts shipment to packing list.
- ◆ Check components in the control housing for loose parts or damage.
- ◆ If any of the above indicate suspected damage, then please notify Siemens Transformadores S.A de C.V. immediately and indicate to the shipping company your concerns written on the bill of lading.

***Note:** If the transformer is shipped via different methods of transportation, i.e. by rail, to ship, to truck, etc. then the above receiving checks should be performed at each change of transportation method. This confirms the integrity of the transformer and will indicate at which point and carrier was involved if damage should occur.*

Storage:

If the transformer is not installed upon receipt at site, then it must be stored as per Siemens Transformadores S.A de C.V. I.L. No. 400 - Storage.

Oil Filling:

- ◆ If shipped gas filled test that the gas in the transformer is dry by dew point and record.
- ◆ Test oil shipped in tankers or barrels for dielectric value (ASTM D877 30 kV minimum) and ppm of water (35 ppm maximum).
- ◆ Indicate level of vacuum achieved and record time duration that this is held.
- ◆ Report dielectric value (ASTM 1816 with 1 mm gap) and ppm of water, of insulating fluid, after passing through filtration and or degasification equipment but prior to entering the transformer.
- ◆ Report dielectric value (ASTM 1816 with 1 mm gap) and ppm of water, of insulating fluid in the transformer. Sample to be taken 24 hours after unit is filled.

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Commissioning:

After the transformer is oil filled perform the commissioning tests and report results:

- ◆ Using a 1000 volt megger test for one minute and record the following:
 - ⇒ Core ground.
 - ⇒ H V to ground. - L V to ground. - T V to ground.
 - ⇒ H V to LV, H V to T V, L V to T V.
- Note:** The minimum acceptable value is 1000 megohms at 20°C. Core ground 100 megohms.
- ◆ Perform a turns ratio test on all three phases on all tap positions, both LTC and OCTC. The result should be within $\pm 0.5\%$ of the calculated values.
- ◆ > Test the power factor of all bushings which have a capacitance tap. Compare readings phase by phase with the bushing nameplate data.
 - > **Note: Power Factor measurements taken below 10 °C are unreliable.**
- ◆ > Test the power factor of all windings. The maximum acceptable value is 0.5% at 20°C.
- ◆ Test polarity, ratio and saturation of all current transformers.
- ◆ Check LTC and OCTC drive operation.
- ◆ Check oil levels in all oil filled compartments, including the bushings.
- ◆ Test all alarm, interlock, trip circuits, and the operation of all ancillary equipment such as pumps (*), cooling motors (*), gas detector relays, sudden pressure relays, pressure relief devices, flow gauges, liquid level gauges, thermometers, etc. to ensure that they operate properly. (* Check rotation of pumps and fans)

Once all inspections and tests are completed then documentation verifying the results **must** be forwarded to the Service Manager, Siemens Transformadores S.A de C.V. When this documentation is received it will be reviewed and any deficiencies or concerns will be identified to the user. When all results are within the acceptable criteria, then Siemens Transformadores will in turn validate the warranty.

Energization:

- ◆ Perform the selected tests of those listed above. Set cooling controls to automatic (if possible), energize the transformer, and hold at rated voltage and no-load for at least 8 h. Test gas blanket for oxygen and combustible gas if transformer is a sealed tank unit. Check operation of LTC mechanism and auxiliary equipment during this time. Note if excessive audible noise and vibration are evident.
- ◆ The transformer is now ready for service. However, observe the transformer carefully (particularly in critical low ambient temperature areas) for the first few hours after load is applied.
- ◆ After several days, retest the dielectric liquid for moisture and dissolved gas, and the gas blanket for oxygen, carbon dioxide, and combustible gas.

Cold starting procedure:

This cold starting procedure applies to energization for ambient temperature below -20 °C. If filled with Luminol Tri Bulk Oil or similar, the cold starting procedure applies to energization for ambient temperature below -40 °C.

Procedure 1 (recommended)

Energize at no-load and hold at no-load for at least 2 hours. Slowly increase the load in 25% increments, allowing a minimum of 30 minutes between each increment. If procedure 1 is not possible, see procedure 2.

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Procedure 2

The transformer shall be energized under no load conditions until the oil temperature reaches -40° C before applying full load.

Operation During Warranty Period:

- ◆ Routine maintenance, inspection and tests indicated in the Instruction Manual, **must** be performed during the warranty period.
- ◆ Testing of the insulating fluid **must** be performed annually and the results forwarded to the Service Manager, Siemens Transformadores S.A de C.V., as noted below. These tests include:
 - ◇ Routine testing of the insulating fluid of the main tank and any LTC compartments for:
 - ⇒ Dielectric Value (ASTM - D1816 with 1 mm gap)
 - ⇒ Power Factor at 20°C
 - ⇒ Interfacial Tension
 - ⇒ Acidity Level
 - ⇒ Dissolved Water Content (ppm of water)
- ◆ Gas in oil analysis (main tank only) **must** be performed once a month for the first 3 months, then at 6 months and then at 12 month periods. If the transformer is gassing then the test results must be forwarded to Siemens Transformadores for evaluation and recommendation for continued operation of the transformer.

Inspection Of On Load Tap Changers During Warranty Period:

- ◆ Inspection or repairs to On Load Tap Changers **must** be performed by a Service Technician approved by Siemens Transformadores, during the warranty period.

Forced Outages During Warranty Period

- ◆ If the transformer is tripped off line then the commissioning tests **must** be repeated in order to determine the integrity of the transformer, before it is put back into service. Siemens Transformadores S.A de C.V. **must** be notified of the conditions of the outage and review the test results before re-energizing the transformer.

Warranty Claims:

Any warranty claims for parts, service or defects are to be forwarded in writing to the Service Manager, Siemens Transformadores S.A de C.V., as soon as possible. Siemens Transformadores S.A de C.V. will only be responsible for costs incurred under warranty and for those items and services for which it has provided prior written authorization. Siemens Transformadores S.A de C.V. will not be responsible for claims for components which have been installed incorrectly by the customer or his subcontractors.

All warranty and testing correspondence should be forwarded to:

Siemens Transformadores, S.A. de C.V.
 km 8 Carretera Guanajuato-Silao
 36250 Guanajuato, México
 Postal box: 299
 Guanajuato, Gto. Mexico
 Tel. 011 52 (473) 735-17-38
 Fax. 011 52 (473) 735-17-44
 Email:
 jose_luis.alvarez@siemens.com

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Shipping - General	IL 100
Transformer Shipped with Oil Removed & Air Dry Filled	IL 205
Lifting and Moving	IL 300



DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS SHIPPING - GENERAL

All transformers are assembled and tested completely at the factory. They are then shipped in as complete a state as shipping clearances will permit. They are carefully inspected and prepared for shipment by personnel experienced in the handling and shipping of this type of equipment. A Packing List is supplied which inventories all items disassembled from the main unit (such as radiators, conservator tank, relief vent, bushings, new gaskets, etc.) for reassembly at site. The outline drawing also indicates all major components which are removed for shipping purposes.

When bushings are removed for shipment, a special lead support may be provided, when necessary.

In the case of draw lead bushings, it is essential that the lead be properly protected against strain and damage during transit. There are three (3) alternative methods used to secure these leads, depending on conditions:

Method 1:

The lead is coiled and securely tied to an eyebolt or other temporary brace just inside the bushing mounting opening.

Method 2:

The lead is coiled and securely tied to a convenient support at the top of the core and coil assembly.

Method 3:

The lead is coiled and securely tied to a support, which is part of the blanking plate used to close the bushing mounting opening.

When temporary shipping braces are required to be removed then I.L. 200 is issued and included in the instruction manual. Temporary shipping braces are painted Chinese Red and caution decals are affixed to all manhole covers and to the area adjacent to the diagram nameplate.

All components such as radiators, pumps, etc. which are oil-filled in service, have the openings closed off by covers or blanking plates, to ensure protection from the atmosphere. It is advisable to add further protection by storing indoors, prior to assembly on site (refer to the I.L. in the Instruction Manual regarding storage). Hardware for mounting parts is attached or assembled prior to assembly on site. Hardware for mounting parts is attached or assembled to the pertinent part. Where necessary, new gaskets are supplied for assembly purposes. In addition, parts removed for shipping are tagged with the item number of the appropriate packing list. All parts should be examined before reassembly to make sure that they are dry, clean, undamaged and free of contamination.

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When two or more transformers are shipped to the same location, parts which are removed for shipping are tagged with the last two digits of the serial number of the transformer to which they belong.

Some transformers may have two or more parts which are similar, but which should each be reassembled in a particular location. Such parts will be match marked in a location at or near their mating surfaces, to indicate in which location they belong.

The numbers marked on cooling fan motors correspond to the fan numbers shown on the outline drawing.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS

Receiving Of Transformers With Oil Removed & Dry Air Filled

GENERAL:

This transformer was shipped with no oil in the main tank. It is filled with dry air and the oil shipped separately.

Accessories likely to be damaged in transit or which would produce excessive shipping clearances were removed and shipped separately. A packing list is supplied which lists all such items disassembled from the main unit and required for reassemble on site. Hardware for mounting is attached or assembled to each pertinent part. When necessary, new gaskets are supplied for assembly purposes. Reusable nitrile rubber gaskets are normally provided.

ARRIVAL AT SITE:

On arrival at site, a thorough external inspection should be made before the unit is removed from the car or float, to ensure that no damage has occurred during transit. Check if the transformer has shifted on the car, and if blocking, steel cables, etc., are intact. Pay particular attention to the pressure gauge, which should show a positive pressure. Before shipping, the tank was filled with dry air to a positive pressure of 35-kPa (5 p.s.i.). It may be assumed that a positive pressure indicates that no outside air has entered the tank. Opening, slightly, any convenient valve on the transformer can make an additional check. If the pressure is positive, a hissing sound will be heard, and a pressure of gas escaping can be felt by hand.

This transformer is provided with core ground connections, which are accessible on the outside of the tank, as described in instruction leaflet 602 included in this manual. It is important to check the insulation resistance between the core and the tank before the transformer is removed from the car. If the transformer is provided with ancillary transformers, such as a series transformer, there will be a core ground connection for each core and each one should be tested. For a complete description of the core grounding system and method of measuring insulation resistance, See I.L. 602.

It is advisable to check the dew point of the gas in the tank, before the transformer is opened to atmosphere. This should be done in accordance with ASTM D 2029-78. NOTE: Before shipping, the dry air had dew point of -40°C (i.e. 0.0127% moisture content by volume, ASTM D 2029-78), or better. Depending on the time between shipping and inspection on site, a new equilibrium between the dry air and the oil impregnated transformer insulation may be reached. Consequently, a change in the dew point of the dry air may occur. A dew point of -40°C (i.e. 0.431% moisture content by volume, ASTM D2029-78), or better, of the dry air, measured on site provided that a positive pressure still exists, gives assurance that the transformer insulation has not been damaged by moisture. If however, the dew point is above this value, or there is no positive pressure, Siemens Transformadores, S.A de C.V. advice should be obtained. Refer to I.L. 521 for full instructions regarding Dew Point.

If the inspection reveals evidence of damage, indication of rough handling or a grounded core, an inspector representing the carrier should be called in, and Siemens Transformadores, S.A de C.V. field Service should be notified immediately.

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Siemens Transformadores, S.A. de C.V.

Make out a brief report indicating if the equipment has shifted on the car, describe damage to blocking, etc., and list signs of external damage.

If the shipment is equipped with an Impact Recorder, be present when the carrier's agent opens the recorder for examination of the tape. Any readings on the recorder of Zone 3 or above indicate rough handling, for which the carrier is responsible if damage has occurred. Please follow the instructions included inside the Impact Recorder case and please return the complete instrument to Siemens Transformadores, S.A. de C.V.

If there is external damage to the transformer and/or accessories, a damage claim should be filed with the carrier. This claim will be filed by Siemens Transformadores if the transformer was shipped FOB site. If shipped FOB factory, the customer should file a claim.

If there are no signs of external damage to the equipment but if the blocking etc., has been damaged, or if the tape of the Impact Recorder registers Zone 3 or above, a claim should also be filed, or a notation made on the acceptance slip that there are possible internal or hidden damages.

Arrangements should be made for an internal inspection and the carrier's agent should be given the opportunity of being present during the inspection. The carrier's agent should be informed that the inspection will only reveal obvious signs of damage and that internal damage to windings, etc., will only show up when the transformer is put into service.

If the general examination indicates that the transformer is in satisfactory condition, proceed with the installation. If it is not convenient to proceed with the installation immediately, a positive dry air pressure of between 7 and 35 kPa (1 and 5 p.s.i.) should be maintained during the storage.

NOTE: Only dry air having a dew point of -40°C (i.e. 0.0127% moisture content by volume, ASTM D2029-78) or better, should be used to build up the dry air pressure.

The transformer tank may be equipped with a combination vacuum-pressure gauge and relief valve. This gauge should be removed, and the opening in the tank plugged for vacuum filling.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS Lifting and Moving

GENERAL INFORMATION:

- ♦ The instructions and information included in this section are advisory only. They are offered as suggestions to those in need of such guidance and should not be interpreted as restricting the judgment of experienced power company millwrights or professional movers.
- ♦ Before positioning the transformer on a permanent or temporary mounting, the foundation and surroundings should be checked carefully.
- ♦ A large power transformer, as received on a rail car, may weigh 200 to 300 tons. Because all the weight is concentrated in a relatively small area, the stresses on both the transformer and its foundation are considerable.
- ♦ The outline drawing included with this manual provides information on the weight of the unit, the location of lifting lugs, jack steps, hauling eyes and mounting base.
- ♦ If there is any reason to suspect that the proposed location is inadequate in any way, the advice of a competent structural engineer should be obtained before moving is begun.

PREPARING THE TRANSFORMER FOR MOVING:

Newly Received Equipment:

Before moving, newly received transformers should be inspected in accordance with the procedures described in Section 2 of this manual. New equipment should not be unloaded or moved until a release from the receiving authority has been obtained.

INSPECTION OF MOVING ROUTE:

The route, which the transformer will follow, should be cleared of all obstacles or hazards. It should be inspected for:

- ♦ Overhead Clearance:
Measure clearance under any obstruction (wires, doorways, gate frames, bridges, etc.) Allow for clearances required by the moving equipment used.
- ♦ Horizontal Clearance:
Measure width of openings or passages (gates, doorways, space between buildings or other equipment) through which the transformer must move. Allow for clearances required by moving techniques.
- ♦ Slopes or Hills:
If the unit is to be skidded into position, it must never be tilted more than 15 degrees from the vertical. If steep slopes must be negotiated, a skid way must be built or a crane employed.
- ♦ Soft Ground, Broken or Irregular Pavement:
If the ground is soft, or the route surface is broken or irregular, a level skid way or crane way should be constructed.
- ♦ Hidden hazards:
If possible, route inspections should be made under adverse conditions. Moves cannot always be made when circumstances are ideal. Dry pavements may become slippery when wet. Firm ground may become mushy in the rain or during a thaw. Look for the unexpected hazard that may complicate or extend the moving operation. Be prepared for delays or breakdowns.

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LIFTING AND MOVING TRANSFORMERS:

All Siemens Transformadores are designed and built to be moved by either lifting or skidding. The outline drawing furnished with this manual shows the precise location of the various lifting lugs, hauling eyes and jack steps with which your transformer is equipped.

The outline drawing also includes the dimensions of the transformer, its weight, and the weight of the oil when the tank is filled to proper operating level. When making a decision on the moving technique to be employed, the size and weight of the transformer, the job-site conditions and the type and capacity of the moving and lifting equipment must be considered.

MOVING BY CRANE:

Lifting, moving, and positioning a transformer by crane requires equipment and services which can be supplied only by an experienced millwright team or a heavy-equipment moving contractor.

When a crane is used the following general precautions should be observed:

- ◆ Crane lifts should be made only when the regular tank cover is in place and securely fastened.
- ◆ Lift hooks should be attached only to the lifting lugs built into the transformer tank.
- ◆ Spreaders should be used to keep the slings as nearly vertical as possible.
- ◆ Safety ropes or guide lines should be attached only to the hauling eyes at the transformer base and the load should be carefully controlled during the lifting operation. The load should never be permitted to swing freely.

MOVING BY SKIDDING OR ROLLING:

Moving a transformer by skidding or rolling requires services and equipment which can be supplied only by an experienced millwright team or a heavy-equipment moving contractor.

Unless your utility or operation has proven experience with transformer moving, the services of a thoroughly qualified engineering, millwright, or machinery-moving consultant should be obtained.

If lifting by crane is impractical, the transformer can be moved along the ground by:

- (a) Skidding on greased plates, planks or rails,
Or (b) rolling on wood or steel rollers.

Moving a transformer along the ground involves four distinct steps.

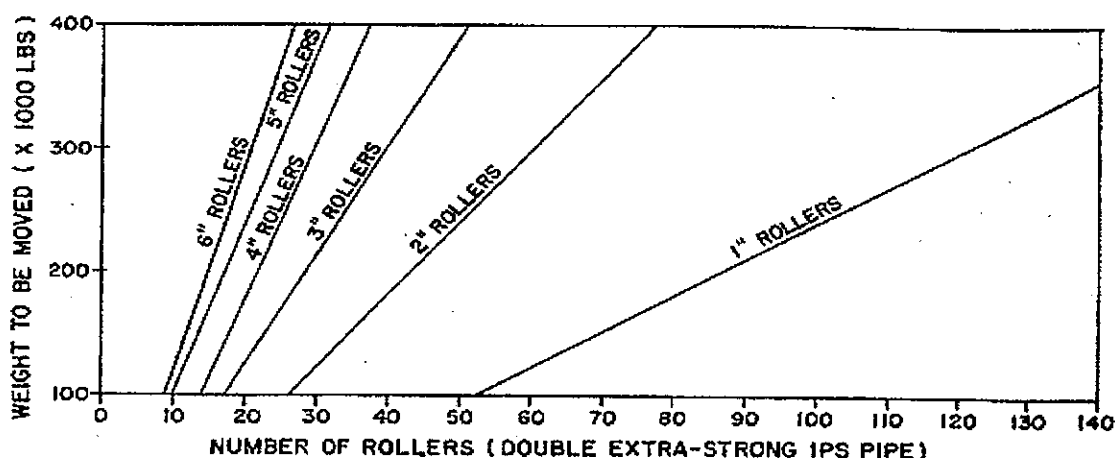
- (1) Building the skid way or rollway;
- (2) Moving the equipment from the truck or railcar to the skid way or roll way
- (3) Skidding or rolling along the ground, and
- (4) Positioning the transformer on the new foundation.

Although details of the moving procedure will vary with the size and weight of the transformer, the condition of the ground over which it must be moved, and the distance which must be traversed, the following general precautions must be observed:

- ◆ The work surfaces (truck bed, rail car deck, temporary foundation, skidway or rollway) must be leveling as possible and absolutely firm. Truck beds and rail car decks should be jacked up off their springs and securely blocked to be both level and firm.
- ◆ Jacks placed anywhere except at the jack steps must never raise the transformer. Jacking operations must be carefully controlled. The transformer should never be raised at only one corner nor should jacks alone be used to support the transformer in a raised position.

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- ◆ When the transformer is to be moved on rollers, all rollers used must be of the same diameter and must be evenly and closely spaced. Rollers must only be placed under the designated rolling area shown on the outline drawing. Rollers may be either wood or metal. Extra-strength iron pipe rollers are recommended. The number and size of iron pipe rollers may be selected from the following curves:



- ◆ Skidway or rollaway must be level and firm. Skidway timbers should be large and solid. If rollers are to be used, the base timbers should be faced with steel plate and a separate rollway should be provided for each set of rollers. If the transformer must be turned on the skidway or rollway, the turning area surface must be large enough to allow working space for men and equipment.
- ◆ Movement of the transformer must be controlled at all times. A tow-and-drag winching system is recommended, with one winch pulling in the direction of movement and a second acting as a brake.
- ◆ Tow cables must be attached only to the hauling eyes provided on the transformer. Additional hitching eyes lugs or cleats should never be welded to the transformer tank. Tow cables should never be looped around the tank or attached to radiators, pipes or other tank accessories. Spreading yokes should be used to equalize towing forces. Spreading yokes must be used if the hitch configuration will place undue strain on the towing eyes or hooks fastened to the transformer.
- ◆ The transformer must never be tilted more than 15 degrees from the vertical in any direction. If the transformer is to be turned on a skid or rollway, pulling on diagonally opposite towing eyes should control movement. The transformer should never be pushed in any direction by pressure against the tank sides or attachments.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores S.A de C.V.

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Section 3

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Storage	IL 400



DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS

Storage Of Transformers Shipped Gas Filled

Several methods can be used for storing the transformer over either a short or long period of time. The basic criteria is that the method used must keep the transformer dry and protect the accessories from moisture damage.

RECEIPT OF THE UNIT

Upon receipt of the unit at site it must be inspected for damage or movement during transportation.

Receive the transformer and perform the following inspections prior to unloading:

- ♦ Check impact recorder (if applicable) and report any abnormal reading to Siemens Transformadores Field Service.
- ♦ Check for external damage and state of tie down bolts, cables or rods.
- ♦ Check gas pressure using a plus or minus 35 kPa (± 5 p.s.i.) gauge, ambient temperature (liquid temperature gauge) and record readings. A positive or negative pressure will indicate the transformer is sealed and has not breathed to atmosphere. A reading of zero may indicate a leak.
- ♦ Megger core ground and record reading. Use a 500 or 1000 volt Megger. Any reading greater than 100 Megohms indicates proper core insulation.
- ♦ Check condition of boxes and components shipped separately. Verify parts shipment to packing list.
- ♦ Check components in the control housing for loose parts or damage.
- ♦ If any of the above indicate suspected damage, then please notify Siemens Transformadores immediately and indicate to the shipping company your concerns written on the bill of lading. More detailed instructions on how to proceed will then be provided.

If the above checks are normal then proceed with unloading and moving the unit to its foundation.

Note: Refer to the *Instruction Manual* for complete receiving instructions.

FOUNDATIONS

It is preferable that the transformer be installed on its permanent foundation as soon as possible.

However, if the permanent foundation is not yet available, a temporary foundation should be built. The design and construction of temporary foundations for storing the transformer is the responsibility of the customer. Design must be based on weight of unit, soil bearing capacities and changes in seasonal conditions, which may affect foundation stability. Temporary foundations will normally consist of layers of timbers placed on a bed of compacted granular stone or gravel of an appropriate depth. The transformer should be stored level and should never be stored on rollers, blocks or jacks.

Inspect the temporary foundation at least once a season for the condition of the supporting materials and shifting of the unit, particularly under conditions of abundant rainfall, freezing and thawing.

INSULATION DRYNESS

The transformer must not be put into storage until it has been determined to be dry.

The acceptable criterion for determining dryness is the dew point measurement for gas filled units.

If a unit has an unacceptable dew point measurement, it must be dried before storage. It is much easier to remove surface moisture before storage, than to remove moisture that has migrated deeply into the insulation after several months of storage.

Note: Refer to the *Instruction Manual* and I.L. 521 for procedure & instructions.

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INVENTORY OF PARTS

It is recommended that, before any items are stored, an inventory of all parts is made and all shortages reported to Siemens Transformadores Field Service, Guanajuato plant. The Outline Drawing with the Accessories List, included in the transformer Instruction Manual, is a useful checklist. If this procedure is followed, it will minimize delays caused by missing or damaged parts not recognized until they are needed.

STORAGE OPTIONS

a) Preferred Method

The preferred method of storage is to place the unit on its permanent base, completely assemble and vacuum oil fills the transformer. **(Refer to the Instruction Manual for complete procedures.)** After oil filling any dehydrating breather should be installed and, if possible, the alarms associated with liquid and pressure levels placed in service. Perform commissioning tests to determine the integrity of the unit.

Perform routine maintenance, similar to an operating unit, which includes periodic oil dielectric tests, running of fans and pumps, liquid and pressure level checks, alarm checks, inspection for leaks and operational checks of load tap changer equipment. Energize the heater circuits in all control and motor drive housings.

b) Short Term Storage (Up To 3 Months)

Short-term storage is defined as a period of three (3) months from the time the transformer is gas filled at the factory.

Main Tank

- ◆ Siemens Transformadores are normally shipped filled with dry air. They can be stored for up to a maximum of three (3) months from the time of gassing, in this condition. A dew point measurement must be taken and the unit must be dry before being put in storage.
- ◆ A plus and minus 35 kPa (± 5 p.s.i.) gauge must be installed and a pressure reading taken and recorded every two (2) weeks. A plus or negative reading indicates a sealed unit. A reading of zero indicates the unit may be leaking and corrective action is necessary. The leak must be found and sealed. Re-pressurize the unit with -50°C dry air and measure the dew point. It may be necessary to dry the transformer until an acceptable dew point is achieved. **(Refer to the Instruction Manual for more precise instructions.)**
- ◆ Store remaining parts as listed under accessories.

Note: When a unit that has been stored gas filled is installed, a minimum of 96 hours is required between oil filling and energizing. This allows for proper oil impregnation of the insulation, since most of the residual oil will have drained from the insulation during storage.

c) Long Term Storage (Over 3 Months)

If the preferred method (Item a) cannot be done then the following will apply:

- ◆ After an acceptable dew point is achieved and the unit is determined to be dry, install the conservator and relief vents (if supplied) in their normal position or in a storage location. Proceed to vacuum fill the tank with dry oil to normal conservator level **(Refer to the Instruction Manual for complete procedure.)** Install the silica gel breather (if so equipped). Dielectric oil tests should be done annually.
- ◆ Remaining parts to be stored as described under accessories.

TEMPORARY GROUND CONNECTIONS:

All transformers stored in temporary locations or on the permanent pad should be grounded as though the installation was permanent. Ground connections to both the tank and installed accessories should be checked carefully if any temporary wiring to controls or heaters is to be connected.

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ACCESSORIES

1. Parts Requiring An Indoor Heated Area:

- ♦ Control and mechanisms housings if shipped separately. If the cabinets cannot be stored indoors in a heated area, they should be mounted in their normal location on the transformer. Openings in the housings should be sealed. The heaters should be connected to a power supply in order to keep the inside of the housing warm and to prevent condensation. Check heating monthly.
- ♦ Bushing potential device cabinets should be stored in an indoor heated area.
- ♦ Silica gel breathers and connection boxes should be stored in an indoor heated area.
- ♦ Any adhesives, touch-up paint and spare gaskets are to be stored in an indoor heated area.

2. Parts Requiring Covered Storage - No Heat Necessary:

- ♦ Fan; fan modules and FOFA coolers. It is recommended that these parts be stored in a dry and sheltered location. If mounted with the motor shaft horizontal both plugs should be removed. If the shaft is vertical the plug close to the shaft end should be removed. As the fans have ball bearings it is recommended that the fans be rotated once a month to change the position of the bearings. This is to guard against damage to the bearings due to vibration inside the building.
- ♦ Oil pumps. If the storage period will exceed 3 months, the oil pump must be partially filled with oil. The oil level must be sufficient to cover the motor bearings. To prevent rust formation in the space above the oil the pump should be sealed with dry air. As the pumps have ball bearings it is recommended that the fans be rotated once a month to change the position of the bearings.
- ♦ Coolers, heat exchangers, all gauges, instruments, gas detector relays, remote position indicators, Qualitrol relief vents, etc.
- ♦ Heat exchanger (water to oil) should have anti-freeze put into the waterside, to mix with residual water inside and to prevent tubes from cracking due to freezing water.
- ♦ Crates of small miscellaneous parts.
- ♦ Conduits, oil piping, valves, fittings, etc. These parts should be sealed with screw caps, screw plugs or flanged plates.
- ♦ Resistor assemblies

3. Parts Suitable for Outdoor Storage:

- ♦ Radiators are sealed with a gasket cover plate. Radiators should be stored off of the ground in a vertical position in order to minimize rusting on the edges. For storage longer than six- (6) month's silica gel bags should be placed inside after purging with dry air.
- ♦ Bushing stacks and pockets are sealed with a gasket cover plate. For storage longer than six- (6) month's silica gel bags should be placed inside after purging with dry air.
- ♦ All lightning arrests and discharge counters may be stored outdoors in the shipping crates in a vertical position.
- ♦ All bushings may be stored outdoors in their shipping crates.
- ♦ Conservator tanks, explosion vents, radiator headers, etc. should be purged with dry air and sealed.
- ♦ Metal parts, ladders, etc. may be stored outdoors.
- ♦ On load tap changers should be purged with dry air and sealed or filled with oil to their normal level.

Note: All parts should be stored a minimum of 100 mm (4 inches) above the floor or ground whether they are in shipping crates or not.

♦ It is recommended to plug all tapped holes on items store outdoors in order to prevent rust.
These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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Oil Filling under Vacuum	IL 521

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS INSTALLATION - Hazards and Precautions

The turn's ratio between windings of many transformers makes them capable of transforming what are normally considered to be harmless voltages to dangerous and even lethal levels.

Electric welders, continuity checking instruments and insulation testing apparatus are examples of sources of so called harmless voltages; even where these are direct current devices, they are capable of producing voltages high enough to be hazardous to human life, when circuits to which they are connected are made or interrupted.

Other situations which may present hazardous conditions include the high voltages produced by open circuited current transformers, which have current flowing in their primary circuits, and the electrical charge, which may be retained by condenser bushings after transformers, have been disconnected from external circuits.

Oil passing through filter papers may acquire electrostatic charge, which will be transferred to the transformer windings as the transformer is filled. Under some conditions the electrostatic voltage on the winding may be hazardous to personnel or equipment.

To avoid these hazards all transformer terminals as well as the tank and oil filtering equipment should be grounded during installation.

If tank is nitrogen filled, personnel employed in the installation procedure should be cautioned against breathing the nitrogen. Before entering a transformer, which was, shipped nitrogen filled, the tank must be purged with dry air having a dew point no higher than -40°C . the purging operation must continue until there is sufficient oxygen with the transformer for normal breathing. The dry air should be admitted through a lower valve such as the sampling valve and the nitrogen exhausted through an upper valve or open manhole cover.

Moisture may condense on any surface cooler than the surrounding air. Moisture in insulation or oil lowers its dielectric strength and may cause a failure of the transformer. The transformer should not be opened under circumstances, which permit the entrance of moisture. If the transformer is brought to a location warmer than the transformer itself, the transformer should be allowed to stand until all signs of external condensation have disappeared.

After placing the main section on site, mount and install the radiators (or unit coolers), conservator tanks, and all parts which do not necessitate opening the transformer tank to the atmosphere.

When installing parts that necessitate opening the transformer to the atmosphere, this period should be kept to an absolute minimum.

It is desirable that the temperature of the core and coil assembly be a few degrees higher than the ambient temperature, in order to prevent condensation on the core and coil assembly. Bushings and relief vents, etc. should be installed only during favorable weather.

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Careful attention must be paid to ensure that all gaskets are properly seated on the gasket surfaces at the time of installation. Gasket surfaces must be clean and should be washed with a solvent if oil or grease is present. When mounting a gasket in a vertical plane, an oil-proof adhesive (such as "Heildite" jointing compound) should be used to hold the gasket in place during installation.

If conditions are satisfactory for proceeding with oil filling, consult the appropriate instruction in this section before starting the work.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE
INSTRUCTIONS
INSTALLATION INSTRUCTIONS
Current Transformer Secondary Connections

The secondary winding of current transformers for customer's connection have been short-circuited at the terminal strip. The bare wire jumpers or the links on the short circuiting type terminal block should be left in place until permanent connections are made.

This precaution is taken to prevent damage to the current transformer windings by the high voltage, which develops across an open circuited secondary winding.

WARNING

An open circuited secondary winding of a current transformer will develop High voltages which may cause equipment damage and /or injury and death.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS PCB CONTENT OF INSULATING FLUIDS

Askarel (Pyranol, Polychlorinated - biphenyl or PCB) is an insulating fluid, which was used for many years in transformers due to its fire resistance. The use of askarel has been banned in North America. In those transformer plants where Askarel filled transformers were built, great care has been taken to remove all traces of this fluid. At this point in time, we are fully confident that all units shipped from our plants are PCB free, i.e. the PCB content is below 1 ppm. Tests are performed regularly on our systems to ensure that they are within specification.

For new transformer orders, when specified by the purchaser, fluid samples are taken from transformers and sent to a testing laboratory to determine that they do not exceed the maximum PCB content specified. These units are then shipped from our plants with a certified test report as to the PCB content of the insulating fluid.

Larger transformers are generally shipped without insulating fluid and filled on-site with oil purchased from the nearest acceptable source. Also, some units are shipped partially filled and "topped-up" on-site. Once these transformers are completely filled and if there is a minimum PCB content guarantee, it is required those samples be taken and sent to a testing laboratory to determine their PCB content. There are several acceptable laboratories throughout North America and the world that are able to perform these tests. Generally laboratories which provide gas in oil analysis and normal oil testing can also provide testing for PCB.

A copy of the laboratories test report should be sent to Siemens Transformadores to be filed with other test data for each unit tested.

CAUTION

This transformer was processed and filled with oil at the factory that met the PCB requirements in effect at the time. The Purchaser should take the necessary precautions to ensure that PCB contamination is not introduced during the field oil filling or maintenance of the transformer.

If the field test results indicate that the PCB content does not meet the contract requirements then we will ask for verification that all equipment used for oil processing was tested and met the specification.

We will also ask for a sample to be taken as per instructions issued by Morgan Schaffer and the sample to be sent to them for PCB content testing. They can be contacted as follows:

Morgan - Schaffer
5110 Courtrai Avenue,
Montreal, Quebec, Canada H3W 1A7
Phone: 514-739-1967 Fax: 514-739-0434

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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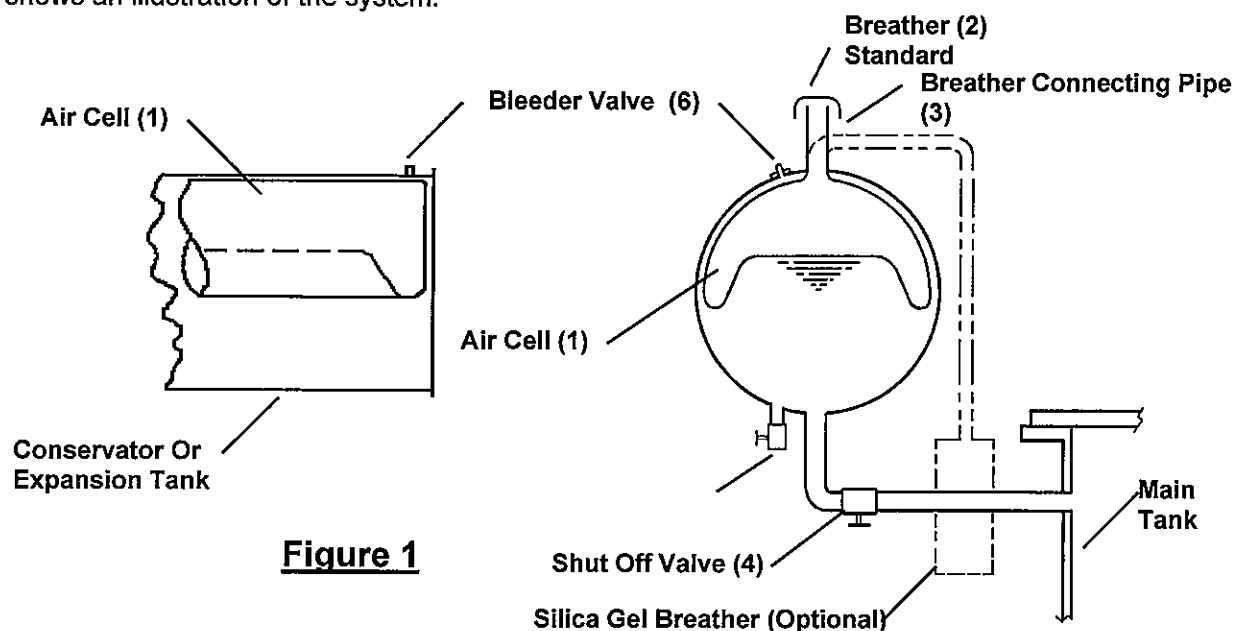
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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS SEALED CONSERVATOR TANK FILLING AND DRAINING INSTRUCTIONS

The conservator air cell preservation system provides a head of oil in an expansion tank above the main transformer tank so that the transformer tank is filled at all times. The quality of the insulating oil is preserved by sealing the oil from atmospheric contaminants such as moisture and oxygen. Figure 1 shows an illustration of the system.



As the oil level falls or rises, air is drawn into the air cell (Part 1 Figure 1) or is expelled through the breather (Part 2 Figure 1). The air cell effectively prevents the transformer oil from coming in direct contact with atmospheric air. The air cell will seal the insulating liquid at atmospheric pressure, inflating or deflating as the oil volume changes in the conservator tank.

- ♦ The conservator tank is normally shipped with the air cell deflated and the breather (Part 2 Figure 1) in place.
- ♦ Before proceeding with the installation of the conservator tank it is necessary that the air cell be pressure tested and sealed as per **Pressurizing or Testing Air Cell** on page 3 of this instruction.
- ♦ With the air a cell sealed and under pressure installs the conservator tank and connects the piping to the main tank.
- ♦ After the main tank is filled with oil to just below the cover (as per the Instruction Leaflet for vacuum oil filling), proceed to fill the conservator tank with oil using the following step by step instructions.

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Filling Instructions:

1. Once the vacuum in the main tank has been broken to dry air then open the shut off valve (Part 4 Figure 1) in the connecting pipe between the main tank and the conservator tank.
2. Open-air release bleeder valves (Part 6 Figure 1). *Note: We recommend that tygon tubing be connected to these valves and run to a pail at ground level in order to catch initial over flow of oil.*
3. Connect oil inlet hose, from degasifier or filter unit, to conservator drain valves (Part 5 Figure 1).
4. Feed oil into the conservator tank slowly (approximately 8 gallons (32 liters) per minute).
5. When oil starts to run out of the bleeder valves (Part 6 Figure 1) close these valves and shut off the oil supply.
6. Release the pressure on the air cell and install the breather supplied with the transformer. *Note: This may be the standard breather or an optional dehydrating breather depending on which type was ordered with the transformer.*
7. Add more oil until the liquid level gauge indicates approximately half full (25°C level).
8. Bleed air from the bleeder valves at all high points on the transformer. i.e. from bushing turrets, gas detector relay, manhole covers, oil headers, etc.

Note: Oil will flow from the conservator tank into any air filled pockets. Do not permit the oil level in the conservator tank to drop below minimum as this may over inflate the air cell. As the oil approaches minimum, close the bleeder valves and replenish the oil in the conservator tank. Then open the bleeder valves again.

When oil appears at the bleeder valve close it off. When all of the air is bled off, add more oil if necessary to bring the level to normal. If oil is hot then depending on the temperature you may overfill to compensate for contraction when it cools.

Draining Instructions:

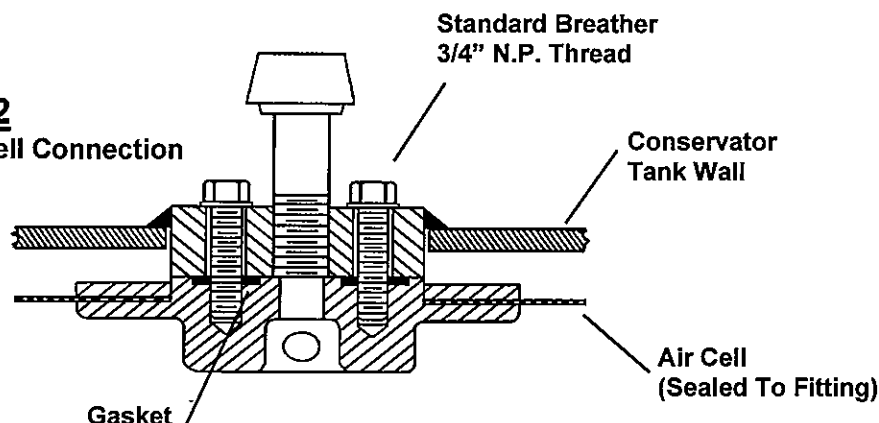
When draining oil from the main tank, care must be taken to ensure that the shut off valve (Part 4 Figure 1) is first closed, then when draining oil from the main tank, open valves on the main cover to admit dry air into the tank. When refilling, it will be necessary to follow instructions number 1 and 8 only from above.

If it becomes necessary to fully drain the oil from the conservator tank, use the following procedure:

1. Drain only sufficient oil to cause the liquid level gauge to read approximately half way between "normal" (25°C level) and "low". This will partially inflate the air cell so that it will be properly prepared for refilling.
2. Disconnect the breather (Part 2 Figure 1) and place a sealing cap on the breather pipe (Part 3 Figure 1).
3. Open bleeder valves (Part 6 Figure 1) at the top of the conservator tank and continue the draining process.
4. Refill as per original instructions noted above.

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Figure 2
Cross Section of Air Cell Connection



Pressurizing or Testing Air Cell:

For installation or to test the integrity of the air cell please follow the following instructions:

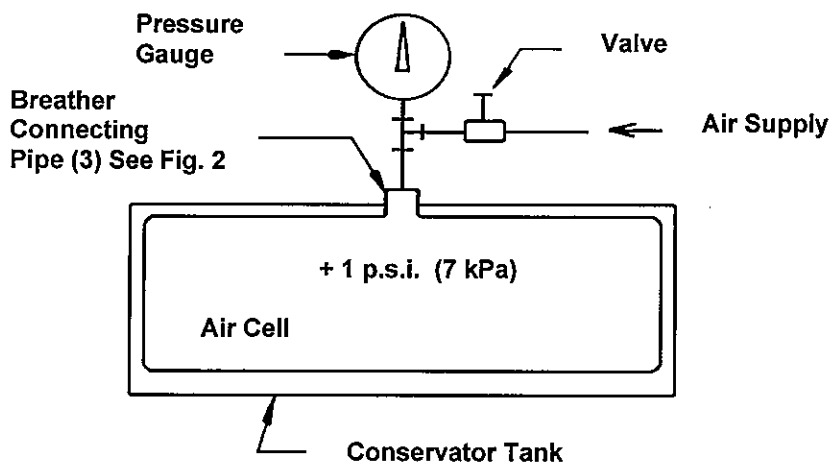


Figure 3

WARNING

⇒ Be sure the transformer is de-energized prior to and while working on the conservator tank.

- ◆ Close shut off valve between conservator tank and main transformer tank (Part 4 Figure 1)
- ◆ Open bleeder valves (Part 6 Figure 1).
- ◆ If the transformer has been in service then drain all oil from the conservator tank and leave the drain valve (Part 5 Figure 1) open during the pressure test.
- ◆ Remove the breather (Part 2 Figure 1) or the connecting pipe from the air cells connection as shown in Figure 2. Attach the necessary piping to connect a pressure gauge, valve and an air supply.
- ◆ Inflate the air cell gradually to approximately 1 p.s.i. (7 kPa). This pressure should not drop over a four (4) hour period. If the pressure drops then the air cell is faulty and should be replaced.
- ◆ Follow oil-filling instructions to return to service.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores, S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE

INSTRUCTIONS

Vacuum Treatment And Oil Filling Of Transformers Shipped Gas Filled

This Instruction Leaflet covers all transformers shipped gas filled. The gas may be either dry air or nitrogen. Normally dry air is used because of safety concerns. The type of gas used is indicated on the transformer tank.

This instruction covers both sealed type and conservator type transformers. Before a transformer is placed in operation, it must be filled with oil in accordance with the procedure outline below. This procedure ensures that the transformer is dry and has a high dielectric strength when it has been prepared correctly for service.

WARNING

Do not enter the transformer or breathe the internal atmosphere unless the oxygen content of the gas inside the transformer is at least 19.5%, carbon monoxide content does not exceed 35% and combustible gases must be less than 10%.

Gas Pressure and Dryness

The pressure in the transformer should be measured as soon as possible after arrival. Measurement should be made using a low-pressure compound gauge, attached to an opening that is above any oil that may be in the transformer. The transformer will have been pressurized at the factory to approximately 4 p.s.i. (28 kPa) at approximately 25°C. In the absence of any leaks, the pressure may fluctuate with temperature in either direction from this value. If a positive or negative pressure reading is obtained, the tank is probably free of leaks. If the gas in the tank is at atmospheric pressure, there is probably a leak in the tank. Add dry gas immediately to approximately 3 p.s.i. (20 kPa) and check for leaks. Once the leaks are found and sealed then perform a Dew Point test.

CAUTION

Check the pressure and take a Dew Point measurement prior to opening the transformer.

Special Precautions for Units Stored under Gas:

- ♦ When a unit has been stored in gas for three months or longer it is necessary to take special precautions during the installation, assembly, vacuum drying and oil filling processes. Transformers stored in gas allow the oil that has been absorbed into the insulation, to drip out into the tank. Obviously, as the time period extends then more oil drips out. If the insulation is exposed to atmosphere it is susceptible to rapid absorption of moisture into the insulation.

A Dew Point test must be performed prior to opening the transformer and starting the installation process.

- ◆ If the unit is found to be dry by Dew Point measurement then it is important to preplan the work in order to limit the exposure time to install all components and for performing an internal inspection. It is also important to obtain dry gas with a preferred Dew Point of -60°C .
- ◆ If the transformer is found to be wet by having an unacceptable Dew Point then the transformer must be vacuum dried until an acceptable Dew Point is obtained, then vacuum filled with oil and left to soak for a minimum of 72 hours. Follow procedures for drawing vacuum and oil filling located elsewhere in this instruction.

Measurement of Insulation Dryness by Dew Point Method:

Notes:

- ◆ Drying operations in the factory reduce the moisture content of the paper insulation to a very low level. This dry condition must be maintained. If there is reason to question the dryness, the amount of moisture can be estimated by a Dew Point measurement for units shipped in dry gas, or by measurement of insulation power factor for units that are oil filled.
- ◆ Dew Point measurement of the gas can be made with an Alnor model 7000U (or model 7300) fog chamber type or similar dew point tester, following instructions provided with the tester.
- ◆ A positive gas pressure is required to permit sampling for a Dew Point test, preferably not higher than 5 p.s.i. (35 kPa).
- ◆ A wait period of twenty-four (24) hours is required after gas filling the transformer and before taking a reading. This is to allow the gas and the surface of the insulation to reach a condition of equilibrium.
- ◆ Compensation for gas pressure is not necessary between 0 and 5 p.s.i. (0 and 35 kPa).
- ◆ The preferred time is early in the morning before the sun's effect becomes significant and when the temperature indicator and winding temperature indicator provide accurate estimates of the internal gas temperature and are within 3°C of the ambient temperature.
- ◆ For Dew Point measurement readings use dry air with a Dew Point of -50°C minimum (-60°C preferred) to pressurize the tank to 2 p.s.i. (14 kPa).

Measure the Tank Gas Dew Point:

Dew Point is very sensitive to temperature changes; therefore it is essential that the insulation temperature be accurately determined. Some instruments will not provide an accurate Dew Point reading below an ambient temperature of 0°C . Review the instructions for the instrument for readings below 0°C .

Calculate the insulation temperature. This is considered to be the average of:

- ◇ the 24 hour ambient;
- ◇ the tank gas temperature;
- ◇ And the tank bases temperature provided they are within a range of 3°C .

If this condition cannot be satisfied use the tank base temperature as the insulation temperature. The top oil and thermometer reads the gas temperature.

Using the curve of Figure 1, determine the maximum permissible Dew Point. This curve which can be used for transformers gas pressures of 0 to 3 p.s.i. (0 to 20 kPa) is based on the insulation surface having average moisture content of 1% and the gas having a pressure of 3 p.s.i. (20 kPa).

A Dew Point reading that is sufficiently low, as determined from Figure 1 indicates that the transformer insulation is dry enough to proceed with installation or vacuum drying and oil filling.

A Dew Point reading that is too high indicates the presence of moisture on the surface of the insulation. If the transformer is found to be wet by having an unacceptable Dew Point then the transformer must be vacuum dried until an acceptable Dew Point is obtained.

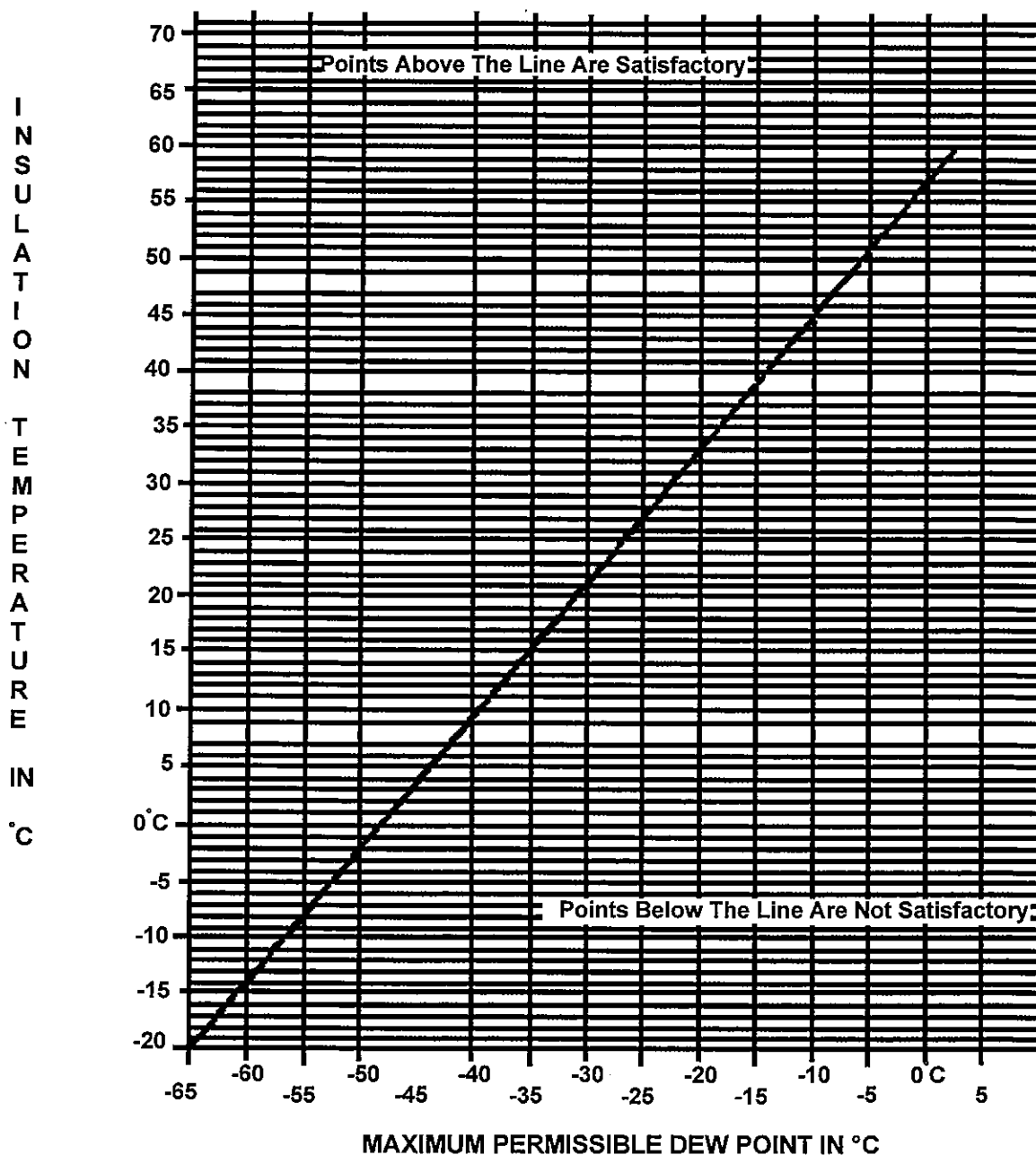


Figure 1

1. Enter Curve at Insulation Temperature °C At the Left.
2. Move To Dew Point Line.
3. Read the Maximum Permissible Dew Point °C On Bottom.
4. Use This Curve For Pressure Between 0 And 5 P.S.I. (0 And 35 kPa)

Table 1 – Conversion Of °C To °F

Degrees C	Degrees F	Degrees C	Degrees F	Degrees C	Degrees F	Degrees C	Degrees F
+ 70°C	+ 158°F	+ 35°C	+ 95°F	0°C	+ 32°F	- 30°C	- 22°F
+ 65°C	+ 149°F	+ 30°C	+ 86°F	- 5°C	+ 23°F	- 35°C	- 31°F
+ 60°C	+ 140°F	+ 25°C	+ 77°F	- 10°C	+ 14°F	- 40°C	- 40°F
+ 55°C	+ 131°F	+ 20°C	+ 68°F	- 15°C	+ 5°F	- 45°C	- 49°F
+ 50°C	+ 122°F	+ 15°C	+ 59°F	- 20°C	- 4°F	- 50°C	- 58°F
+ 45°C	+ 113°F	+ 10°C	+ 50°F	- 25°C	- 13°F	- 55°C	- 67°F
+ 40°C	+ 104°F	+ 5°C	+ 41°F	- 30°C	- 22°F	- 60°C	- 76°F

Note: 1°C Equals 1.8°F; 1°F Equals 0.555°C.

Equipment Requirements:

The following is a list of acceptable auxiliary equipment for vacuum treatment and oil filling of transformers. It is given for reference purposes only. It is not intended to be a complete listing of approved materials, devices, or suppliers.

Device for Measuring Dew Point:

- ◆ Dew Point measurement of the gas can be made with an Alnor model 7000U (or model 7300) fog chamber type or similar dew point tester, following instructions provided with the tester.

Vacuum Pump:

- ◆ Minimum recommended size of vacuum pump is one with 150 CFM (70 dm³/sec) capacity or greater. The pump must also be capable of attaining a blank off pressure of 0.01 mm Hg (1.3 Pa) or less. This may be part of the Oil Processing Equipment described below.

Vacuum Gauges:

- ◆ Hastings Electronic Vacuum Gauge with a scale of 0 to 20-mm Hg.

Oil Processing System:

- ◆ An oil processing system capable of filtration, degasification and dehydration is required for some of the procedures. This equipment must be capable of delivering oil at the transformer with the following characteristics:
 - ◇ Gas Content 0.5% maximum by volume.
 - ◇ Temperature Minimum 20°C, Maximum 75°C
 - ◇ Dielectric Value of Oil Minimum 32 kV (Per ASTM D1816 with 1mm (0.04") gap.)
 - ◇ Water Content Maximum 10 ppm (Per ASTM D1533)
 - ◇ Volume 600 minimum to 2,000 gallons per hour (2,300 to 7,600 liters).
 - ◇ Filtration Minimum of 5 microns (1 micron preferred).

Oil and Vacuum Hoses:

- ◆ Hoses must be compatible for use with transformer insulating oil.
- ◆ Oil hoses should be a minimum of 1-inch diameter. 2 inches is the preferred size.
- ◆ Vacuum hoses should be a minimum of 2 inches diameter. 4 inches is the preferred size.

Dry Gas:

- ◆ Bottles of dry Air (Breathable) or Nitrogen (-50°C to -60°C Dew Point) with hose and pressure regulator.

*** Device for Measuring Dielectric Value of Oil:**

- ◆ A dielectric tester designed for up to 60 kV value with interchangeable test cups in order to perform both test methods ASTM D-1816 (with 1-mm gap) and ASTM D-877.

◆ Device For Measuring Moisture Content Of Oil:

Equipment to measure the dissolved water content in the oil as per ASTM D1533 test method.

*** Note:** Items marked with an asterisk (*) are preferred to be available for use at site. If this is not possible then close and ready access to a laboratory where these tests can be performed is required.

CAUTION

**The core and coil assembly must be heated to a minimum
Of 10°C before vacuum drying and oil filling takes place.**

Vacuum Drying:

The primary purpose of vacuum drying is to remove surface moisture and absorbed gas. To remove moisture with vacuum only, the temperature of the core and coil assembly must be above 10°C.

The following procedure can be used to elevate the temperature of the core and coils:

- ◆ Drain all oil from the transformer.
- ◆ Close all cooler or radiator valves to maintain heat.
- ◆ Pull vacuum as specified in Table 3 (Vacuum Treatment and Oil Filling Requirements). Hold at this vacuum or less for 6 hours.

CAUTION

**Direct the oil spray so it does not splash on the bushing porcelain.
If this is not possible, raise the oil temperature gradually to avoid thermal shock.
Failure to do this may break the bushing porcelain by thermal shock.**

- ◆ Spray hot oil in through the cover of the transformer using the top filter press connection point, as indicated on the Transformer Outline Drawing. Maintain a vacuum of 10 mm of Hg or less on the transformer tank during the oil spraying operation in order to avoid oxidation of the oil, and to aid in the removal of gas from the insulation. Pump the oil from the bottom drain valve of the transformer through a vacuum degasifier and filtration system, which is equipped with a heat exchanger, and back to the cover of the transformer.
- ◆ Use the minimum amount of oil necessary to establish circulation.
- ◆ The oil temperature entering the top of the transformer should be between 50°C and 75°C. Continue spraying the hot oil under vacuum until the temperature of the core and coils is well above 10°C. The temperature of the core and coils will be elevated to equilibrium conditions when the output oil temperature from the transformer becomes constant, and then the temperature of the core and coils will be near the temperature of the output oil. The heating rate can be increased by closing the bottom valves to the coolers or radiators and by using simple blanketing on the outside of the tank.
- ◆ After raising the temperature of the core and coils then drain all oil from the transformer and proceed with:
 - ◇ The vacuum and oil filling process outlined on page 9
 - ◇ **OR**, if the transformer was wet by Dew Point Measurement circulate the hot oil for a minimum of 24 hours under vacuum as described above then drain all oil, maintain a vacuum of between 0.10 to 0.25 mm of HG (100 to 150 microns) for a further 24 hours, then pressurize with dry air and perform Dew Point test. Repeat vacuum drying cycle until an acceptable Dew Point reading is achieved.

Vacuum and Oil Connections:

- ◆ Connections from the vacuum pump to the transformer tank must be as short as possible and as large in diameter as possible. The line must be a minimum of 2 inches in diameter, and preferably 4 inches in diameter, especially on larger transformers.
- ◆ There should be no low spots in the vacuum line in which water or oil can collect.

Vacuum and Oil Connections: (Continued)

- ◆ The vacuum system must be capable of attaining a blank off pressure of 0.03 mm Hg (4 Pa) or less.
- ◆ The vacuum piping must be so related to the oil piping so oil will not splash or spray into the vacuum line.
- ◆ Siemens Transformadores are normally provided with a quantity of two, two inch pipe openings on the top of the transformer and are diagonally opposite each other. One is for the vacuum connection and the other for the oil connection. Refer to the Transformer Outline Drawing for their location. Using these connection points oil entering the tank will spray against the windings and other objects inside the tank, so that any gas and moisture in the oil can more readily removed by the vacuum. The fittings are located so that oil will not spray in front of the opening to the vacuum line.
- ◆ The efficiency of most vacuum pumps is dependent upon the condition of the pump oil. If the vacuum pump oil becomes cloudy from moisture or thins out because of insulating oil contamination it should be changed.

Pressure Measurement:

- ◆ The pressure in the tank during vacuum operations must be measured through a connection to the top section of the transformer tank above the oil level. Do not use pressure measurements at locations other than the transformer tank itself.
- ◆ For measuring the pressure in the tank a properly calibrated Hastings electronic gauge measuring mm of Hg on a scale of 0 to 20 mm is recommended.
- ◆ Install a 0 to 100 p.s.i. (700 kPa) pressure gauge on the oil inlet side of the valve at the cover.

Vacuum Leaks:

- ◆ The entire vacuum system must be free from leaks. Otherwise it may be difficult or impossible to attain the specified vacuum levels.
- ◆ Any leaks will permit moist atmospheric air or water to be drawn into the transformer.
- ◆ When the minimum required level of vacuum is reached, close the valve at the top of the transformer where the vacuum line is connected.
- ◆ Record the vacuum level on the transformer tank once the valve is closed. Record the vacuum level every 10 minute for a thirty-minute period. The increase in pressure should not exceed 0.50 mm Hg in any 10-minute period.
- ◆ If the leak rate is greater than above then the leaks must be found and repaired.
- ◆ The leak test must be repeated until satisfactory.
- ◆ If all of the leaks have been repaired and this leak rate cannot be obtained, this may indicate that the transformer insulation is wet. Check the Dew Point.

Weather:

It is permissible to perform vacuum operations during inclement weather if the following conditions are met:

- ◆ The tank shall have been successfully vacuum tested for leaks as outlined above.
- ◆ The transformer **top must be covered** with a tarpaulin or other suitable cover to prevent free water from collecting on the tank cover.

The vacuum level must be monitored closely for any sudden rise in pressure indicating a leak in the tank.

Vacuum Application:

Transformer tanks are normally designed to withstand full vacuum. See the Nameplate for pressure/vacuum limits. Refer to specific instructions from the manufacturer of all Load Tap Changers (LTC) for their ability to withstand vacuum and for specific vacuum/oil filling instructions. Also, check the Nameplate concerning other oil filled compartments. (Deflections of tank panels of up to 3 inches may be experienced during this process. Remember, the tank was vacuum tested before leaving the plant.)

Vacuum Procedures:

The vacuum drying and oil filling operations are intended to be a continuous uninterrupted process. If a loss of vacuum occurs, due to power failure, for example, any oil that has been added must be drained out and the process started over. Use dry gas to break the vacuum.

Oil Level Indicator:

It is necessary to know the level of the oil in the transformer tank, in order to observe the rate and level of filling and to avoid the danger of pulling oil into the vacuum pump. An approved 1/2 inch (14 mm) outside diameter heavy wall plastic tube (Tygon or equivalent) capable of withstanding full vacuum, connected to the bottom drain valve and any convenient valve at the top of the tank. This will provide a visible indication of the oil level.

Required Oil Quality:

Dielectric Test

The dielectric breakdown voltage of an insulating liquid is of importance as a measure of its ability to withstand electric stress without failure. It is the voltage at which breakdown occur between two electrodes under prescribed test conditions. It serves primarily to indicate the presence of suspended contaminants such as water, dirt, lint, cellulose fibers, carbonized oil, or conducting particles in the liquid, one or more of which may be present when low dielectric breakdown is found by testing. However, a high dielectric breakdown voltage does not indicate the absence of all contaminants.

Two methods are recognized for measuring the dielectric breakdown voltage of oil.

Dielectric Test as Per ASTM D-877

This test specifies a test cup equipped with one-inch diameter vertical disc electrodes spaced 0.100 inch apart. ***This method is recommended for the routine acceptance of new, unprocessed oil from a vendor but IS NOT recommended by Siemens Transformadores for testing insulating oil processed into equipment or contained in equipment supplied by us.***

Dielectric Test as Per ASTM D-1816

This test specifies a test cup equipped with spherical electrodes spaced either 0.040 or 0.080 inch (1 or 2 mm) apart. This cup includes a stirrer and makes this test more sensitive to the presence of particle contaminants and moisture in the oil. ***This method is recommended for the routine acceptance of insulating oil processed into equipment or contained in equipment supplied by us but IS NOT recommended by Siemens Transformadores for testing insulating oil received from a vendor.***

Insulating oil shipped from the refinery (tankers or barrels) must have the following values:

- ◆ Dielectric Strength (by ASTM D-877) - 30 kV minimum, 35 kV average.
- ◆ Water Content (by ASTM D-1533) - 35 ppm maximum.

Oil received at site must be checked to ensure that it meets the above characteristics. Oil supplied in drums presents a problem. If it cannot be unloaded to a holding tank then random sample approximately every 10th drum for dielectric strength.

Required Oil Quality: (Continued)

Oil received from the refinery may be moved to oil storage facilities at the site or processed and then pumped into the transformer when it meets the oil quality requirements.

The insulating oil must have the following values prior to it being allowed to enter into the transformer:

- ◆ Dielectric Strength (by ASTM D-1816 with 1 mm gap [0.04 inches]) - See Table 3 for corresponding voltage class. *Only if testing by ASTM D-1816 is not possible*, then the oil may be tested by ASTM D-877 method, *and must be a minimum of 43 kV*.
- ◆ Water Content (by ASTM D-1533) - See Table 3 for corresponded voltage class.

Oil filling according to these instructions and using the correct equipment, will ensure that oil received from the refinery, which complies with the test values given above, will enter the transformer at the required values from Table 3.

CAUTION

This transformer was processed and filled with oil at the factory that Met the PCB requirements in effect at the time. The Purchaser should Take the necessary precautions to ensure that PCB contamination is not Introduced during the field oil filling or maintenance of the transformer.

Preparation for Oil Filling:

- ◆ Exposure time should be as short as possible to keep absorption of moisture by the insulation to a minimum.
- ◆ Valves on the tank for mounting removable radiators do not seal completely. To prevent gas leakage during shipment the valve openings are covered with gaskets steel plates. These plates must remain in place until the radiators are ready for mounting.
- ◆ Both conventional conservator tanks and sealed conservator tanks with air expansion cells are not designed to withstand vacuum unless specified by the customer and indicated on the outline drawing. *Unless otherwise specified on the outline drawing (none vacuum) conservator tanks must have the valve between the conservator tank and the main tank closed during all vacuum-filling operations.*
- ◆ Some manufacturers Load Tap Changers require special precautions for vacuum filling. Please refer to the specific Load Tap Changer instructions for details.
- ◆ **Do Not** operate Load Tap Changer or Off Circuit Switch when the unit is under vacuum.
- ◆ Do not connect gas detector relays or sudden pressure relays to piping until after vacuum filling.
- ◆ Valves to cooling equipment and radiators must be open before vacuum is drawn.
- ◆ It is recommended that all external connections to the bushings be disconnected prior to pulling vacuum. The transformer tank will flex under vacuum causing movement of the bushings. This movement may cause stress at the bushing connection and cause damage, which could result in damaged seals and oil leakage from the bushing. Loss of oil will cause a failure.

CAUTION

The transformer tank must be grounded at all times. Bushings must be grounded after installation except during tests and when the transformer is in operation. All oil handling equipment and vacuum pumps must be grounded. Maintain equipment grounds for a minimum of one hour after oil filling. Disregarding any of the above can result in static discharges injuring personnel and damaging the transformer.

Vacuum and Oil Filling Process:

After assembly has been completed, measure the insulation dryness by Dew Point method. Apply a pressure of 5 p.s.i. (34 kPa) for a minimum of 6 hours to check for leaks. With no leaks, and providing the transformer is dry by Dew Point measurement proceed with the instructions outlined below.

If the transformer is not dry by Dew Point measurement follow the instructions on page 5 for Vacuum Drying. Repeat this process until the transformer is dry by Dew Point measurement.

When the transformer is dry by Dew Point measurement proceed as follows:

- ◆ Draw a vacuum of 1 mm of Hg (135 Pa) absolute pressure and perform the leak test as described on page 6. When all leaks have been fixed proceed to the next step. See diagram for typical vacuum filling connections and location of gauges.
- ◆ Draw vacuum to the level and for the time period indicated in Table 3 for the voltage class of the transformer.
- ◆ **Before allowing oil to enter the transformer tank it must be tested and meet the required oil quality indicated on page 8 and in Table 3.**
- ◆ Install an oil level sight gauge as previously described.
- ◆ Maintain the level of vacuum specified in Table 3 as oil is allowed to enter the tank. Throttling of the oil valve may be necessary in order to maintain the vacuum at this level. If a vacuum pump of sufficient capacity is used, the rate of flow can be 1,000 gallons (3,600 liters) per hour without any appreciable loss of vacuum.
- ◆ Adjust the oil-filling valve to maintain a positive pressure up to the valve.
- ◆ Fill the main transformer tank to approximately 6 inches (150 mm) below the cover. **Sealed Type Transformers** (i.e. non-conservator type) should be filled until the oil level gauge on the side of the tank reads **Minimum**. Shut off the oil supply.
- ◆ Shut off the vacuum valve to the transformer tank. Break vacuum by admitting dry air or nitrogen into the tank (above the oil level) at a pressure not greater than 5 p.s.i. (34 kPa), until a slight positive pressure is obtained. The tank and radiators will expand slightly, causing the oil level to fall.
- ◆ Equalize the tank pressure to atmosphere. Any bleeder or other valve at the top of the transformer may be used for this purpose.

Sealed Type Transformers: (i.e. non-conservator type)

- ◆ Remove vacuum lines, gauges, and other temporary fittings. Replace any parts, which were removed for the vacuum process.
- ◆ Add oil while bleeding off air until the oil level gauge on the tank wall is at the correct level for the temperature of the oil. Remove oil lines, gauges, and other temporary fittings.
- ◆ Seal the tank. Using dry air or nitrogen pressurizes the tank to approximately 2 p.s.i. (14 kPa).
- ◆ For units fitted with a nitrogen gas pressure system, you must refer to I.L. 814.

Sealed Conservator Tank with an Air Expansion Cell:

Complete the oil filling process as outlined in I.L. 516 or 517 in the Instruction Manual.

Conventional Conservator Tank: (Without Air Cell)

- ◆ Remove vacuum lines, gauges, and other temporary fittings. Replace any parts, which were removed for the vacuum process. Connect the conservator piping, if not already connected and gas detector relay.
- ◆ Remove the oil lines, gauges, and other temporary fittings from the cover.
- ◆ Connect the oil line to the drain valve of the conservator tank.
- ◆ Add oil to the conservator tank. This oil will flow from the conservator tank into the main tank. Continue adding oil until the oil level gauge on the conservator tank registers Minimum.
- ◆ Bleed air from the high points of the transformer, such as bushing turrets, inspection covers, radiator headers, gas detector relay, etc.
- ◆ Do not allow the oil level in the conservator tank to drop below minimum, as this will allow more air to be drawn into the transformer.
- ◆ Continue adding oil and bleeding off air until all air is removed and until the oil level gauge on the conservator tank is at the correct level for the average temperature of the oil.
- ◆ Remove oil lines, gauges, and other temporary fittings.

Note:

- ◆ Some manufacturers Load Tap Changers require special precautions for vacuum and oil filling. Please refer to the specific Load Tap Changer instructions for details.
- ◆ Also, check the Nameplate concerning other oil filled compartments.

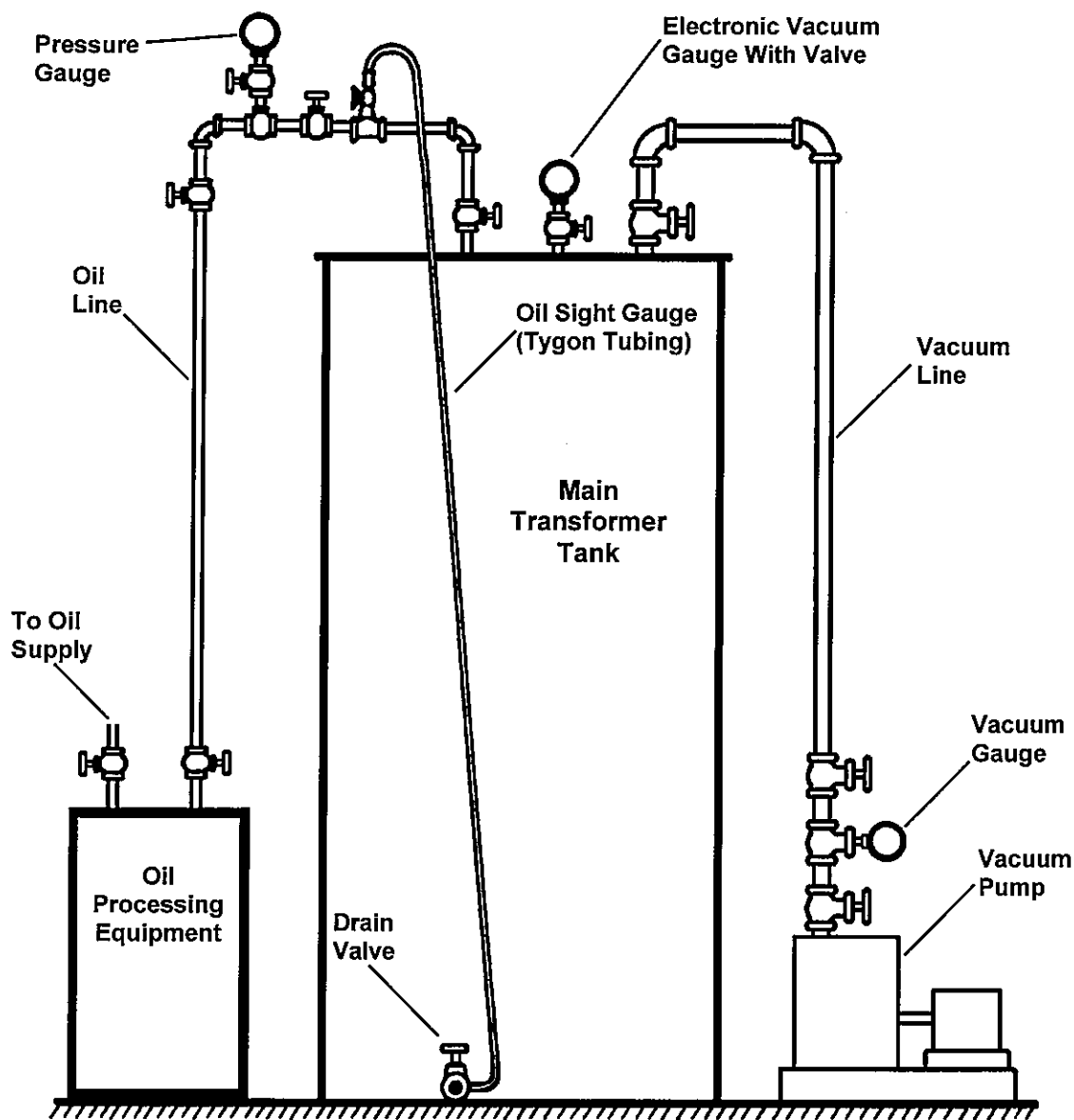
Waiting Time:

- ◆ After filling is completed, the transformer should be allowed to stand the allotted time given in Table 3 for the voltage class of the transformer, before energizing the transformer.
- ◆ If the transformer has oil-circulating pumps, they should be operated during this waiting period.
- ◆ During this period oil samples should be taken and sent out for full analysis and testing.

Note:

Before energizing the transformer Commissioning Tests specified in the Warranty Validation I.L. #003 must be completed and reported to Siemens Transformadores for approval.

These instructions do not purport to cover all details or variations in equipment or to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores.



Vacuum Filling Connections

Typical Piping Arrangement for Vacuum Drying and Oil Filling Of A Transformer

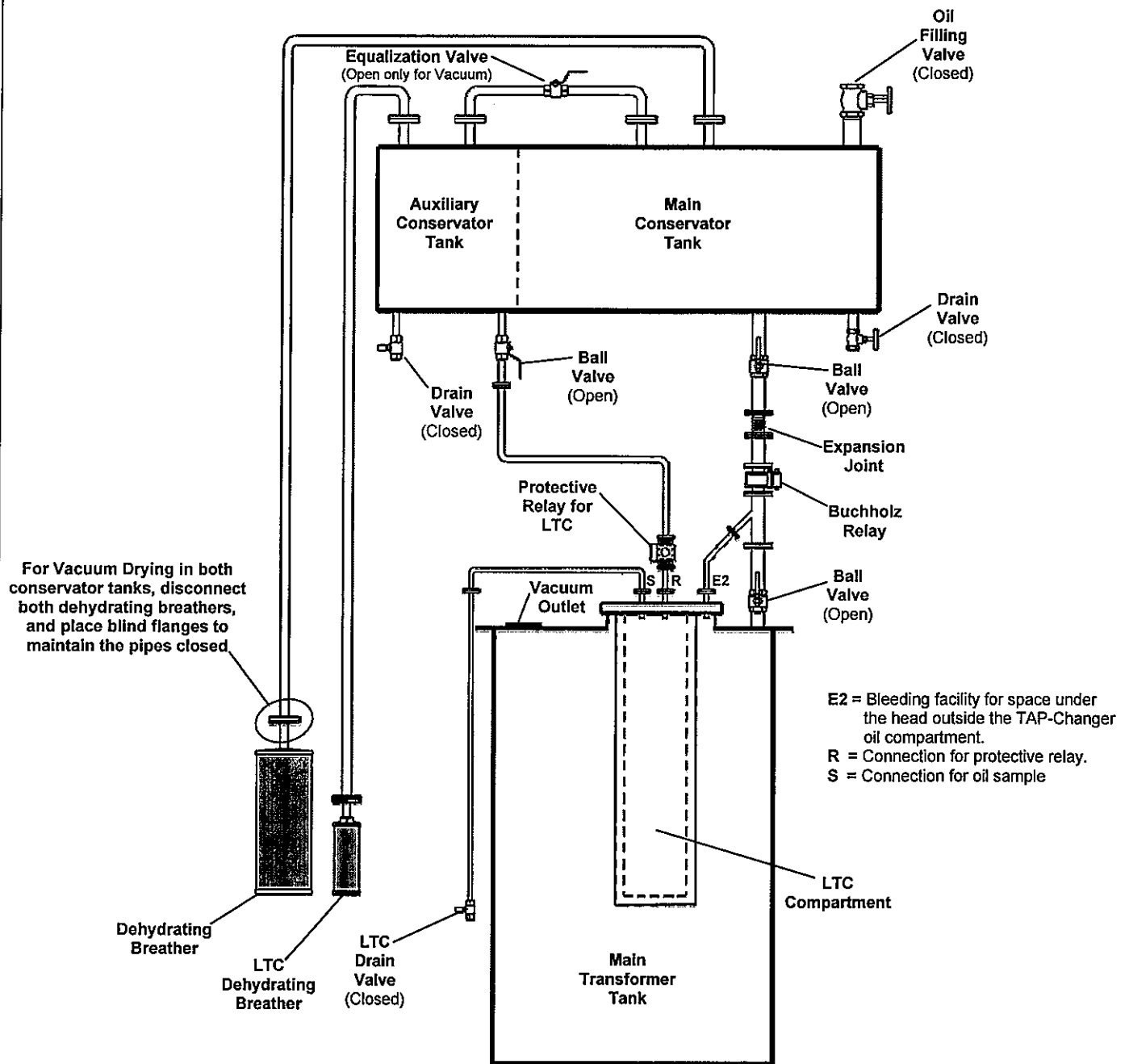
Conversion Data - Table 2

Equivalents To (1) Atmosphere Are:

29.92 inches of mercury (in. Hg) @ 32 °F
 759.968 mm of mercury (mm Hg) @ 32 °F
 14.6959 pounds per square inch (p.s.i.)
 101,325 Pascal (Pa)
 101.325 kilo Pascal (kPa)

Millimeters (mm) Of Mercury (Hg) Vacuum To Pascals (Pa)
 To Inches (in.) To Torr To Microns

1 mm Hg = 133.32 Pa = 0.03937 in. Hg = 1 Torr = 1000 microns
 2 mm Hg = 266.66 Pa = 0.07874 in. Hg = 2 Torr = 2000 microns
 3 mm Hg = 399.98 Pa = 0.11811 in. Hg = 3 Torr = 3000 microns
 4 mm Hg = 533.28 Pa = 0.15748 in. Hg = 4 Torr = 4000 microns



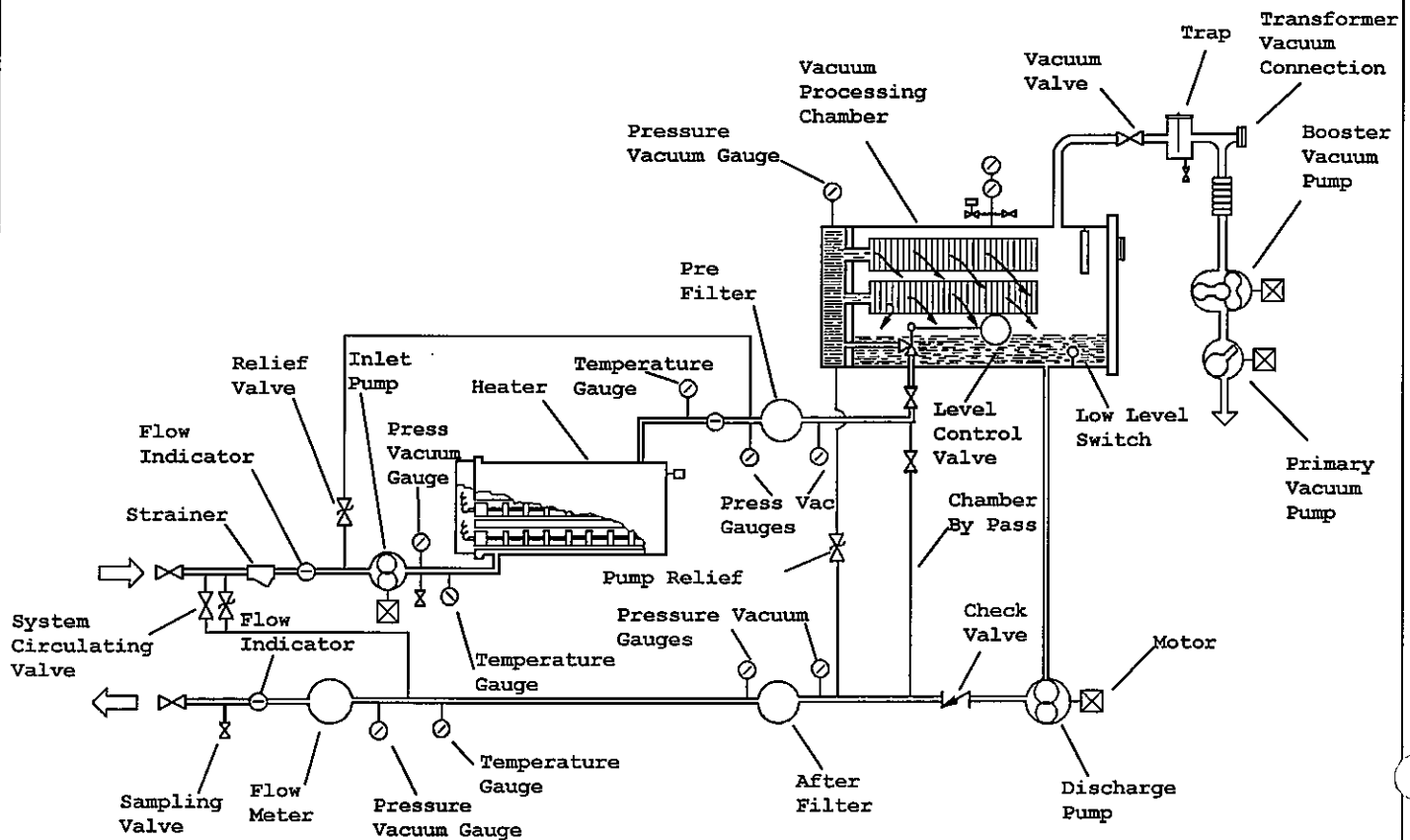
Vacuum Filling Connections Piping Arrangement for Vacuum Drying

Conventional Conservator Tank and Auxiliary Conservator Tank: (Without Air Cell)

- Follow instructions as outlined for *Conventional Conservator Tank*, and open the valves indicated in the diagram *Vacuum Filling Connections*, and keep them closed all others. Dehydrating breathers must be disconnected and the pipes sealed.

Procedure / Treatment ↓	Voltage Class →	69 Kv & Below	70 To 230 kV	Above 230 kV
Breathable Dry Air Used For Purging Unit. Minimum Dew Point Of Air To Be Used is:		- 50 °C (-60 °C Preferred)	- 50 °C (-60 °C Preferred)	- 50 °C (-60 °C Preferred)
Minimum Acceptable Dewpoint Of Gas In Transformer, Prior To Vacuum Drying is:		See I.L. Chart	See I.L. Chart	See I.L. Chart
Air Quality For Internal Inspection: Minimum Oxygen Content, Maximum Carbon Monoxide Content & Maximum Combustible Gases		≥ 19.5 % O ₂ < 35 % CO < 10 % Gas	≥ 19.5 % O ₂ < 35 % CO < 10 % Gas	≥ 19.5 % O ₂ < 35 % CO < 10 % Gas
Core & Coil Temperature To Be Minimum Of		10 °C	10 °C	10 °C
Drain Residual Oil In Transformer (See Note # 1)		YES	YES	YES
Open All Cooler, Pump & Radiator Valves		YES	YES	YES
Vacuum, Absolute Pressure, Maximum (mm of Hg [Mercury]) OR Pa (Pascals)		2 mm Hg 265 Pa	1 mm Hg 135 Pa	1 mm Hg 135 Pa
Minimum Vacuum Hold Time At Above Level Before Starting Oil Fill Is: (See Note # 2)		8 Hours Plus	12 Hours Plus	18 Hours Plus
Temperature Of Oil Entering Transformer:		Min. 20 °C Max. 75 °C	Min. 40 °C Max. 75 °C	Min. 40 °C Max. 75 °C
Pump Oil Through Filtering Equipment:		YES	YES	YES
Pump Oil Through Degassing Equipment:		Recommended	YES	YES
Minimum Dielectric Value Of Oil When Received At Site By Tanker Or Barrels (as per ASTM D877)		30 kV	30 kV	30 kV
Minimum Dielectric Value Of Oil Before Entering Unit (As Per ASTM D1816 with 1mm (0.04") gap.)		30 kV	30 kV	32 kV
Maximum Water Content Of Oil When Received At Site By Tanker Or Barrels (As Per ASTM D1533)		35 ppm	35 ppm	35 ppm
Maximum Water Content Of Oil Before Entering Transformer (As Per ASTM D1533)		15 ppm	10 ppm	10 ppm
Maximum Vacuum Level To Be Maintained During Oil Filling:		3 mm Hg 400 Pa	2 mm Hg 265 Pa	1 mm Hg 135 Pa
Wait Time After Oil Filling To Energization (See Note # 3)		18 Hours	24 Hours	48 Hours
Notes: 1. All residual oil, which has drained to the bottom of the tank, must be drawn out and circulated through the oil processing equipment. 2. Record the exposure time that the transformer is open to atmosphere. Add one (1) hour of vacuum hold time for each 8 hours (or part thereof) that the unit was open. When the transformer is open to atmosphere it must be continuously purged using dry air. 3. Allow the transformer to stand the prescribed time (or longer) before energizing. This permits the moisture in the oil and insulation to approach equilibrium. If the unit has oil pumps they should operate during this period. When a unit has been stored gas filled for 6 months or longer a stand time of a minimum of 96 hours is required.				

Table 3
Vacuum Treatment and Oil Filling Requirements



Typical Vacuum, Filtration, Degasification and Dehydration System

System Requirements:

- ♦ **Vacuum Pump:** - Minimum recommended size of vacuum pump is one with 150 CFM (70 dm³/sec) capacity or greater. The pump must also be capable of attaining a blank off pressure of 0.01 mm Hg (1.3 Pa) or less. This may be part of the Oil Processing Equipment described below.
- ♦ **Vacuum Gauges:** - Hastings Electronic Vacuum Gauge with a scale of 0 to 20-mm Hg.
- ♦ **Oil Processing System:** - An oil processing system capable of filtration, degasification and dehydration is required for some of the procedures. This equipment must be capable of delivering oil at the transformer with the following characteristics:
 - ♦ Gas Content 0.5% maximum by volume.
 - ♦ Temperature Minimum 20°C, Maximum 75°C
 - ♦ Dielectric Value of Oil Minimum 32 kV (Per ASTM D1816 with 1mm (0.04") gap.)
 - ♦ Water Content Maximum 10 ppm (Per ASTM D1533)
 - ♦ Volume 600 minimum to 2,000 gallons per hour (2,300 to 7,600 liters).
 - ♦ Filtration Minimum 5 microns prefilter. (+1 micron after filter optional).
- ♦ **Oil and Vacuum Hoses:** - Hoses must be compatible for use with transformer insulating oil.
 - ♦ Oil hoses should be a minimum of 1-inch diameter. 2 inches is the preferred size.
 - ♦ Vacuum hoses should be a minimum of 2 inches diameter. 4 inches is the preferred size.
- ♦ **Power Requirements:** - Typically 230, 480, 575 or 600 volt, 3 phases, 100 ampere service is required. If not available at site then rental generators can normally be source.

Table of Contents

Section 5

<u>Description</u>	<u>Ref.</u>
Recommended Inspection & Tests before Placing into Service	IL 600
Measurement of Core-to-Ground Resistance	IL 602
Testing- Determining the Dielectric Breakdown Voltage of Oil	IL 604

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DESCRIPTION ✕ OPERATION ✕ MAINTENANCE INSTRUCTIONS PREVENTATIVE MAINTENANCE FOR TRANSFORMERS
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Maintenance:

Periodic maintenance and inspection of power transformers and their accessories will contribute to the trouble free operation of this vital component in your electrical system. These procedures may identify potential problems before they become serious enough to cause equipment outages.

Always compare current test results with previous readings, looking for indications of change that may indicate a specific problem. Use the gas in oil analysis, standard oil and electrical test results from the initial commissioning tests (I.L. 003 – Warranty Validation) as your base readings.

WARNING

Before performing any tests or maintenance work near the transformer terminals, be certain the transformer is de-energized. Ground the transformer terminals before entering the area at the top of the transformer.

The control circuits may have dangerous voltage levels. De-energize the auxiliary power source before working on any control components.

Failure to follow these precautions may lead to equipment damage, severe personal injury or death.

The frequency of inspection and maintenance procedures will vary with the rating of the transformer, but as a minimum Siemens Transformadores S.A de C.V. recommends the following time intervals and procedures:

Monthly Schedule:

- ✕ Check and record ambient temperature.
- ✕ Check and record the transformer top oil temperature and note the maximum value since the last reading. Reset red pointer.
- ✕ Check and record the transformer winding temperature and note the maximum value since the last reading. Reset red pointer.
- ✕ Check and record all liquid level indicators.
- ✕ Check and record the transformer load current and note the maximum value since the last reading.
- ✕ Check and record the line voltage and note any variation since the previous check.
- ✕ Record number of LTC tap changes from the counter.
- ✕ For sealed units with a gas pressure system, check and record the reading of the pressure gauge on the Nitrogen Demand System. Also check the amount of gas remaining in the bottle and plan replacement as required. If at anytime the pressure gauge on the transformer reads zero then this may indicate a leak in the transformer. This could be an oil leak, weld leak, gasket leak or a leak in the gas space section of the transformer. This should be investigated by pressurizing the unit to approx. 3 p.s.i. and monitoring it for pressure drop. If the pressure drops significantly in a 24 hour period then a leak is indicated. Any leaks must be found and repaired.

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Quarterly Schedule:

In addition to the monthly schedule perform these additional checks:

- ▣ Visually examine the cooling radiators, heat exchangers, oil piping, valves and gasketed covers for signs of oil leakage. Tighten any loose fittings and repair any oil leaks.
- ▣ Operate the cooling fans and oil pumps to make sure they are all functional.
- ▣ Examine the cooling radiators for accumulation of dirt and foreign material. Remove any debris that might impede airflow.
- ▣ Inspect any breathers and small screen openings in pressure relief devices or a pressure vacuum breather to be certain they are clean and in operating condition.
- ▣ Inspect the Control Housing for the following conditions:
 - Control-circuit voltage.
 - Collection of dirt or gum.
 - Excess heating of parts – evidenced by discolouration of metal parts, charred insulation or odour.
 - Freedom of moving parts (no binding or sticking).
 - Corrosion of metal parts.
 - Remaining wear allowance on contacts.
 - Excess slam or pickup.
 - Proper contact pressure.
 - Loose connections.
 - Worn or broken mechanical parts.
 - Excessive arcing in opening circuits.
 - Excessive noise in A-C magnets.
 - Evidence of dripping water or other liquids in cabinet.
 - Operation – including proper functioning of timing devices and sequencing devices.

Annual Schedule With The Transformer Energized:

In addition to the monthly and quarterly schedules perform these additional checks:

- ▣ Inspect the transformer and components including bushings, lightning arresters, bus duct, etc. with a thermal vision camera. This may indicate any hot spots or poor connections that may have to be inspected while the transformer is de-energized.
- ▣ Take oil samples from the main tank and any oil filled compartments such as the tap changer for analysis. Refer to I. L. 705 for the procedure for taking samples.
- ▣ Test for:
 - Dielectric Value (ASTM - D1816 with 1 mm gap)
 - Power Factor at 20°C } Interfacial Tension } Acidity Level
 - Dissolved Water Content (ppm of water)
- ▣ Take samples for Gas In Oil Analysis. Refer to the I.L. 705 for the procedure for taking samples.

WARNING

Do not take an oil sample from a compartment that has a negative pressure or vacuum while the transformer is energized. Failure to follow this precaution may lead to equipment damage, severe personal injury or death.

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Annual Schedule With The Transformer De-energized: (continued)

In addition to the monthly and quarterly schedules perform these additional checks:

- ▣ Examine all bushings and lightning arrester porcelains for contamination. Clean as required using a soft cloth and a suitable solvent such as acetone, varsol, denatured alcohol, etc.
- ▣ Check all current carrying connections for tightness (includes line and ground connectors, plusterminal points, etc. in the control housing and LTC motor drive).
- ▣ Examine the paint finish, particularly around welded joints and accessory items such as the radiators. Check for paint peeling or cracking and evidence of rust. Clean any affected areas and touch up paint as instructed in the Instruction Manual.
- ▣ Using a 1000 volt megger test for one minute and record the following:
 - Core ground.
 - H V to ground. - L V to ground. – TV to ground.
 - H V to LV to TV.

Note: The minimum acceptable value is 1000 megohms at 20° C. Core ground 100 megohms.

- ▣ Perform a turns ratio test on all three phases on all tap positions. The result should be within $\pm 0.5\%$ of the calculated values.
- ▣ * Test the power factor of all bushings that have a capacitance tap. Compare readings phase by phase with the bushing nameplate data and previous test results.
- ▣ * Test the power factor of all windings. Compare readings to previous test results.
- * Note: Power Factor measurements taken below 10° C are unreliable.*
- ▣ Test polarity, ratio and saturation of all current transformers.
- ▣ Check OCTC drive operation.
- ▣ Check oil levels in all oil filled compartments, including the bushings (where possible).
- ▣ Test all alarm, interlock, trip circuits, and the operation of all ancillary equipment such as pumps (*), cooling motors (*), gas detector relays, sudden pressure relays, pressure relief devices, flow gauges, liquid level gauges, thermometers, etc. to ensure that they operate properly. (* Check rotation of pumps and fans)

Inspection Of On Load Tap Changers:

- ▣ It is recommended that any inspection or repairs to On Load Tap Changers be performed by a Service Technician approved by the Tap Changer manufacturer.
- ▣ Refer to the Instruction Leaflet pertaining to the On Load Tap Changer, included in the Instruction Manual, for recommended maintenance and inspection of this equipment.
- ▣ Record number of tap changes from the counter on a monthly schedule and at the time of any oil sampling, LTC inspections or maintenance.

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In the Event That Trouble Develops Or There Is A Forced Outage:

If the transformer is tripped off line then it is recommended that the following be done in order to determine the integrity of the transformer, before it is put back into service.

- ▣ Take oil samples and gas in oil samples for immediate testing (recommended within 6 hours of fault).
- ▣ Check insulating fluid for:
 - Colour and sediment.
 - Dielectric strength (should be 30 kV minimum or higher by ASTM D1816 with 1 mm gap).
 - Water content by ASTM D1533 (should be less than 25 ppm).
 - Compare gas in oil test results to previous readings.
- ▣ Check Transformer turns ratio on each tap on each phase (TTR).
- ▣ Check resistance on all windings (can be used to detect open circuit).
- ▣ Measure no load loss (can be used to detect short circuit).
- ▣ Megger windings to each other and to ground (readings should be in the order of 1,000 megohms plus).
- ▣ Megger core to ground (reading should be in the order of 100 megohms plus).
- ▣ * Test the power factor of all bushings that have a capacitance tap. Compare readings phase by phase with the bushing nameplate data and previous test results.
- ▣ * Test the power factor of all windings. Compare readings to previous test results.
* *Note: Power Factor measurements taken below 10°C are unreliable.*
- ▣ Compare current test results with previous readings looking for indications of change that may indicate a specific problem.
- ▣ Inspect and test all alarm, interlock, trip circuits, and the operation of all ancillary equipment that was associated with the transformer being tripped off line, to ensure that they operate properly.
- ▣ External visual inspection of the transformer and surrounding equipment.
- ▣ Internal inspection of LTC compartment if test results indicate the problem may be associated with the tap changer (follow procedures, inspections, and tests outlined in manual provided by the tap changer manufacturer).
- ▣ Internal inspection of transformer if test results indicate a need.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores S.A de C.V.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS MEASUREMENT OF CORE-TO-GROUND RESISTANCE

Core grounding is provided by means of a copper strip inserted between the laminations of the core and then connected to a bushing located in a housing on the main cover or tank wall as illustrated in Figure 1. A lead connected between the bushing terminal and a stud completes the ground circuit. **Note: Refer to the Transformer Outline drawing in the Instruction Manual, for the location of the Core Ground Housing.**

The core ground resistance must be tested upon receipt of the transformer and before it is unloaded from the transport vehicle. This will verify the integrity of the core insulation or it may indicate if damage was sustained during transit. The core ground resistance should also be checked as a normal commissioning and maintenance test.

To test the core ground resistance completes the following steps:

- ♦ Remove the cover from the core ground housing.
- ♦ Disconnect the ground lead from the bushing.
- ♦ Using a 500 or 1000 volt Megger connect the test leads to the core ground bushing and to the grounding stud. Energize the megger and record the reading. (The bushing is a 1.2 kV class.)
- ♦ Any reading greater than 100 Megohms indicates proper core insulation.

Caution If the reading is less than 100 Megohms please contact the Service Manager of Siemens Transformadores S.A de C.V.

If there is more than one core and coil assembly in the tank (e.g. main transformer, series transformer, etc.), then each core is grounded through separate bushings or a multi-terminal bushing. Each transformers cores insulation must be tested individually.

Caution The lead connection between the bushing terminal and the ground stud completes the ground circuit and must be in place for normal transformer operation.

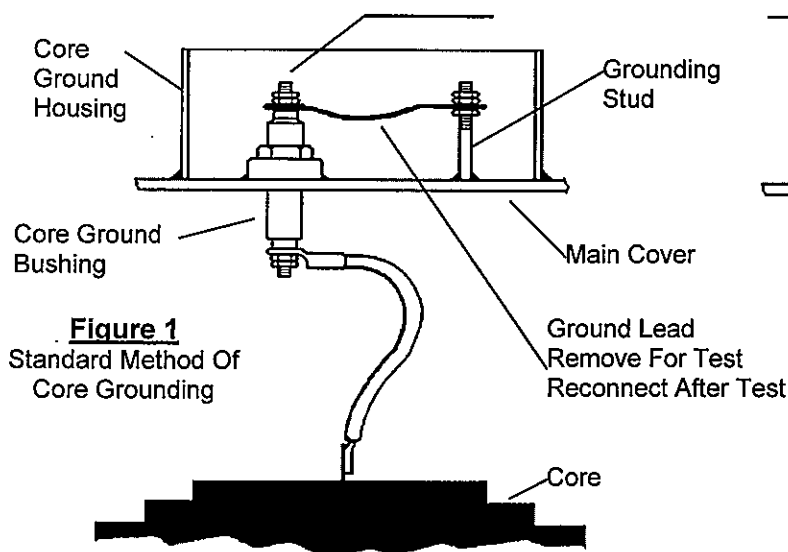


Figure 1
Standard Method Of
Core Grounding

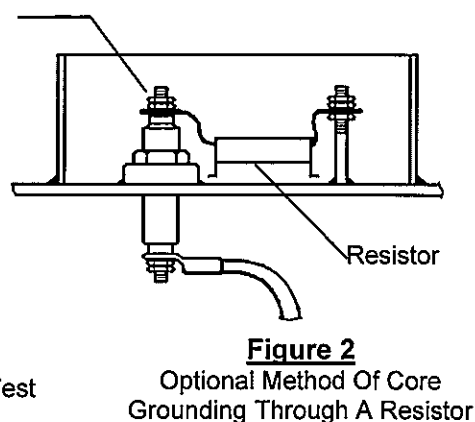


Figure 2
Optional Method Of Core
Grounding Through A Resistor

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS

TESTING - DETERMINING DIELECTRIC BREAKDOWN VOLTAGE OF OIL

There are two ASTM standard test methods for determining the dielectric breakdown voltage of electrical insulating fluids at commercial power frequencies, D 877 and D 1816.

Summary of Methods:

Method D 877 - The insulating liquid is tested in a test cup between two 25.4-mm (1-in.) diameter disk electrodes spaced 2.54 mm (0.100 in.) apart. A 60-Hz voltage is applied between the electrodes and raised from zero at a uniform rate of 3 kV/s.

In order to permit the escape of air, the liquid shall be allowed to stand in the cup for not less than 2 minutes and not more than 3 minutes before voltage is applied.

The square-edged disk electrodes of Method D 877 are relatively insensitive to dissolved water in concentrations below 60% of the saturation level. This method is recommended for acceptance tests on unprocessed insulating liquids received from vendors in tank cars, tank trucks, and drums. It may also be used for the routine testing of liquids from selected power Systems apparatus.

Method D 1816 - The oil is tested in a test cell between spherically capped (VDE) electrodes spaced either 1.02 mm (0.040 in.) or 2.04 mm (0.080 in.) apart. The oil is stirred before and during application of voltage, by means of a motor-driven stirrer. A 60-Hz voltage is applied between the electrodes and raised from zero at a uniform rate of ½ kV/s. There shall be an interval of at least 3 min between filling and application of voltage for the first breakdown, and at least 1-min intervals before applications of voltage for successive breakdowns

The more uniform electric field associated with VDE electrodes employed in Method D 1816 is more sensitive to the deleterious effects of moisture in solution, especially when cellulose fibers are present in the oil, than is the field in Method D 877. Method D 1816 is recommended for testing filtered, degassed, and dehydrated oil prior to, during, and after the filling of power systems apparatus. It is also finding increased usage for testing oils from transformers in service. Filtering and dehydrating the oil may increase D 1816 dielectric breakdown voltages substantially.

In general, the following instructions apply to both methods:

Electrode Spacing:

Check the gap with the electrodes locked in position. Permissible tolerances are ± 0.01 mm for Method D 877, and ± 0.03 mm for Method D 1816.

Temperature:

The temperature of the sample should be equal to or greater than the room temperature, which should be at least 20°C.

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Cleaning:

The test cell and electrodes must be clean and dry. They should be wiped with dry, lint-free tissue or a clean, dry chamois. The cleaned surfaces of the electrodes and other parts must not be touched with the fingers, or with any article which has been in contact with the skin.

The cell should be rinsed thoroughly with a dry hydrocarbon solvent such as Stoddard solvent or kerosene. Do not use solvents which will evaporate rapidly, as they may chill the cell and cause moisture condensation.

Flush the cell with new, dry, filtered oil and make a voltage breakdown test on a sample of the same oil. If the breakdown voltage is in the proper range for this oil, the test cell may be considered as properly prepared for testing.

Preparing the Sample:

To assure even distribution of any impurities in the sample, the container should be gently inverted and agitated. Rapid agitation is undesirable, as it may cause aeration of the liquid. Immediately after mixing, rinse the test cell with a portion of the sample, then fill the cell.

Testing:

Apply a 60-Hz voltage and raise from zero at the rate specified for the method used, until breakdown occurs. Occasional momentary discharges which do not trip the interrupting equipment should be disregarded.

When it is desired to determine the value of the dielectric breakdown voltage of an oil, make five breakdowns on one filling of the cup. Examine the five breakdowns for statistical consistency, and if they meet the criterion described, use their average to determine the dielectric breakdown voltage of the sample. If they do not meet this criterion, make five additional breakdowns on the sample, and use the average of all ten breakdowns as the dielectric breakdown voltage of the sample.

Criterion for Statistical Consistency:

Calculate the mean and standard deviation of the five breakdowns as follows:

$$\bar{X} = \frac{1}{5} \sum_{i=1}^5 X_i \text{ and } s = \sqrt{\frac{1}{4} \left[\sum_{i=1}^5 X_i^2 - 5 \bar{X}^2 \right]}$$

Where: $\bar{X}$ = mean of the five individual values, X_i = i-th breakdown voltage, & s = standard deviation.

If the ratio $s/\bar{x}$ exceeds 0.1, it is probable that the standard deviation of the five breakdowns is excessive and therefore that the probable error of their average is also excessive.

Alternative Criterion:

Calculate the range of the five breakdowns (maximum breakdown voltage minus minimum breakdown voltage), and multiply this range by three. If the value so obtained is greater than the next to the lowest breakdown, it indicates that the standard deviation of the five breakdowns and, therefore, the probable error of their average value is excessive.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS REMOVING AND REPLACING WELDED-ON TANK COVERS

If it becomes necessary to open a transformer in the field, then we recommend the following procedures and precautions:

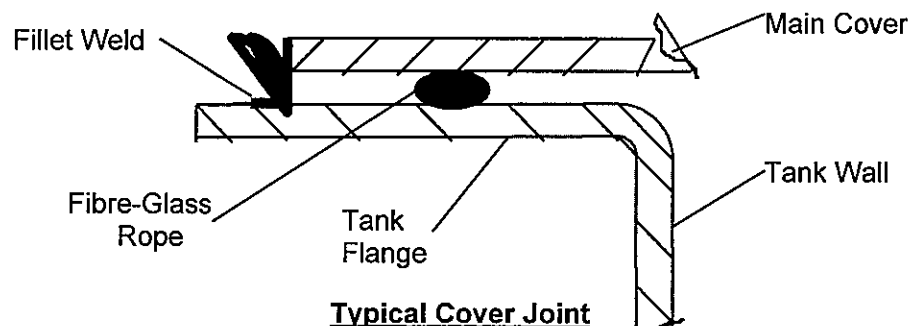
WARNING

- ♦ Most transformers are not designed so that the tank will support the weight if filled with oil and without the cover securely fastened in place. All oil should be drained from the transformer if the cover is to be either removed or welded into place.
- ♦ A transformer must be properly gassed with an inert gas such as nitrogen during any burning or welding operations.
- ♦ Proper personal & safety equipment such as gloves, safety glasses, hearing protection, etc. must be worn by the operators. A suitable work platform is required.
- ♦ Correct fire extinguishers (CO₂) must be available at the job while burning or welding.
- ♦ A fire watch must be posted during burning or welding operations.
- ♦ Before any operator enters a tank, test to see that the air contains at least 19.5% oxygen.

PREPARATION:

Before removing or re-welding a transformer cover the following items should be done in preparation:

- All oil should be drained from the transformer and placed in proper storage.
- All bushings installed in the cover, removable junction boxes, cover mounted LTC's, etc. should be removed and any exposed openings sealed.
- Internal and external connections to bushings, current transformers, LTC leads, etc. should be disconnected.
- Remove any pockets, radiators, coolers, or LTC housings mounted on the tank sidewalls. Where this may not be feasible, block such accessories firmly to grade level.
- Seal all openings in transformer and adjacent equipment.
- Parts of the transformer or adjacent equipment which might be damaged by sparks or hot metal must be protected by fire resistant covering.



A fibre glass rope gasket is placed between the tank flange and the cover to facilitate the safe welding and burning out of the joint. The gasket acts as an arc or flame barrier and provides a partial seal for the inert gas (discussed later) during the cutting or welding operation.

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WELD REMOVAL BY CHIPPING:

One of the two (2) processes used to open the joint weld of a cover is by chipping. This process does not require purging of the tank with an inert gas, but is relatively slow. The equipment required and the suggested procedure are described below.

Equipment Required:

- ◇ A heavy pneumatic hammer.
- ◇ Diamond-point chisels. A 3/8 inch chisel is suitable for the initial cut. A 1/8 inch chisel may facilitate clean-up.
- ◇ A flat chisel, with a slight (1/64 X 1/8 inch) bevel, ground back from the cutting edge on the flat side for better control. It's use facilitates breaking open the joint.
- ◇ Proper personal & safety equipment such as gloves, safety glasses, hearing protection, etc. must be worn by the operators.
- ◇ Vacuum cleaner.
- ◇ Gas analyzer.
- ◇ Fire extinguishing equipment.
- ◇ A suitable work platform is required.

Procedure:

- ◆ It is important that all tank openings be covered to prevent the entrance of chips and metal particles. Apply a lubricant of oil or grease to the joint. The long point of the 3/8 inch diamond-point chisel is directly at the root of the joint. The cut is made along the fusion zones of the fillet flush with the horizontal, but slightly (up to 1/8 inch) back of the vertical face of the fillet. The small diamond point chisel will facilitate the cleaning out of the weld at the root where the weld may have penetrated behind the fusion line.
- ◆ Before the seal is broken the joint is chipped with the flat chisel to put it, as nearly as possible, in condition for rewelding. All loose chip particles are then brushed or vacuumed up and wiped away, so that none can fall into the transformer when it is opened.
- ◆ Also, before the seal is broken, the position of adjoining parts should be accurately match marked or keyed so that they return to the same relative position.
- ◆ The flat chisel is driven directly into the joint to crack the seal. A lift on the cover helps to break the joint open. Covers are to be lifted off carefully, so as not to damage the internal assembly.

WELD REMOVAL BY ELECTRIC CUTTING TORCH:

Opening a welded joint by this method is safe and rapid if proper precautions and procedures are followed. It is especially suitable for larger transformers where the welds are heavier. The following are suggested procedures.

Equipment Required:

- ◇ Bottled nitrogen with hoses and fittings to for connecting to purge valve.
- ◇ Pressure regulator to regulate the pressure of nitrogen during cutting and welding. (1/2 to 5 p.s.i.)
- ◇ Welding equipment - AC or DC. Capacity: 400 amps minimum with overload cutout.
- ◇ Arcair cutting torch. Arcair Model No. 61-062 with 1/4 or 5/16 inch carbon graphite electrodes.
- ◇ Sufficient "C" clamps to permit clamping the cover at about three (3) foot spacing along the joint.
- ◇ Fire extinguishing equipment.
- ◇ Proper personal & safety equipment such as gloves, safety glasses, hearing protection, etc. must be worn by the operators.
- ◇ A suitable work platform is required.

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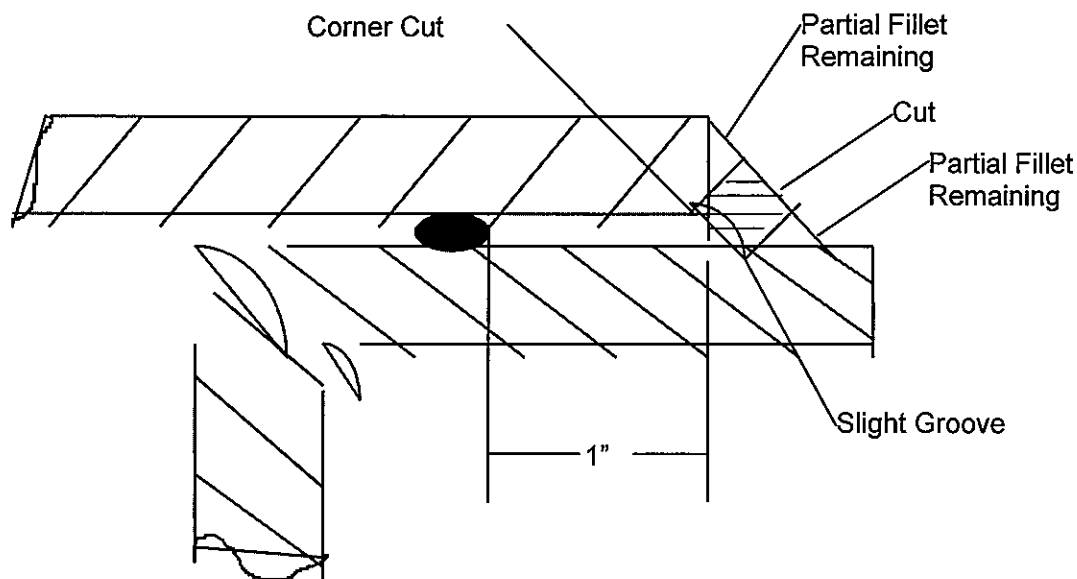
Procedure For Purging The Gas Space:

Before any welding or cutting is performed the gas space must be purged with nitrogen to reduce the oxygen content to 7% or lower. This will reduce the hazard of fire.

- Connect nitrogen supply to purge valve.
- With regulator set to limit the pressure to 5 p.s.i, open nitrogen supply valve.
- Remove bleeder screw from valve on inspection cover or open a valve on the cover.
- Permit nitrogen to flow through the tank until the gas tests the oxygen level at 7% or lower.
- Reduce pressure to 1/2 p.s.i. and leave supply attached.
- Close valve or replace bleeder screw and close tightly.

Procedure For Removal Of Cover:

- ♦ Follow Arcair Instruction Manual, commence removing welds as shown in sketch below:



Typical Section Through Cut Fillet Weld

- ♦ Start at a corner and work along one side, a distance of about three (3) feet. It may be necessary to make more than one pass to cut completely through the fillet weld.
- ♦ Skip about one (1) inch and commence cutting again, repeating process, cutting three (3) foot increments with one (1) inch between until completely around cover.
- ♦ Clamp the cover with one (1) "C" clamp placed close to each one (1) inch uncut portion of the weld. This is to prevent wasting of gas and to ensure positive pressure in the tank when remaining welds are cut.
- ♦ If necessary, to preserve positive gas pressure without excessive loss of nitrogen and to prevent contaminants entering the tank, additional "C" clamps should be used when the gap greater than 3/16 inch develops between the cover and tank flange.
- ♦ Cut the remaining welds.
- ♦ Before "C" clamps are removed all slag and spatter must be cleaned off of tank and cover, so that no contaminants will fall into the transformer when it is opened.
- ♦ The position of adjoining parts should be accurately match marked or keyed so that they return to the same relative position. Shut off nitrogen, remove clamps and remove cover.

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REWELDING OF COVER:

Preparation:

- ◇ Where applicable, replace or reconnect shipping braces, tap changer connecting shafts, shipping braces, side wall bushings, etc.
- ◇ Meeting faces of the cover and tank flange must be free of slag and other foreign matter, a little chipping may be necessary.
- ◇ Ensure that all internal surfaces of the cover and tank flange are free of grease, oil, rust and paint for a distance of not less than 2 inches from point of welding. Use a suitable solvent such as naphtha, isol, or equivalent to clean the cover and tank flange to remove all traces of oil.
- ◇ Great care must be exercised in the clean-up operation to prevent any foreign material from getting into the transformer. This may require some form of barrier, with a sealing lip, that can be moved along the tank flange as the surface is cleaned.
- ◇ A fibre glass cord gasket 0.156 diameter (Owens-Corning EC9-10T) should be placed approximately one (1) inch in from the cover edge with the ends overlapping approximately two (2) inches. Use Blibond Adhesive No. 30 to fasten gasket in position on the flange.

Welding Of Joint:

- ◆ Carefully locate cover in position.
- ◆ Using "C" clamps located at approximately three (3) foot centres, compress the gasket to approximately 1/8 inch.
- ◆ Tack weld approximately 1/4 inch at 16 inch centres.
- ◆ The clamps may now be removed or repositioned.
- ◆ When the edges of the cover are pulled down, a satisfactory seal may be effected by laying a fillet weld at least as large as the original weld, with a single pass. However, if one pass does not adequately fill, or burning gasket cement causes gases to blow out, preventing a good single pass weld, more passes will be necessary.
- ◆ The first fillet is laid in the root of the joint. This is a plugging weld, not expected to provide a perfect seal, but to provide strength and a base for the final welds.
- ◆ Slag must be chipped away after each weld pass.

Testing For Leaks:

- Upon completion of welding, a test should be made for leaks. An acceptable method is, with relief devices mounted, to place the tank under nitrogen or dry air pressure of 5 p.s.i. The weld joint is painted with a soap bubble solution such as glycerine and liquid soap.

Finishing:

- ◇ After leak tests are satisfactorily completed, the joint should be thoroughly cleaned, removing all dirt, slag and oil. A wire brush and an evaporating solvent are effective. Finishing should include one primer coat and two finish coats of paint with adequate drying time between coats.

WARNING

- ◆ Before any operator enters a tank that has been filled with nitrogen the tank must be purged with breathable air and tested to see that the air contains at least 19.5% oxygen.

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DESCRIPTION ♦ OPERATION ♦ MAINTENANCE INSTRUCTIONS

Purging Of Enclosed Spaces To Permit Entry

Prior to any entry into the transformer tank the gas space must be tested to determine the breathable quality of the gas.

WARNING

Do not enter the transformer or breathe the internal atmosphere unless the oxygen content of the gas inside the transformer is at least 19.5%, carbon monoxide content does not exceed 35% and combustible gases must be less than 10%. Dry air shipment does not imply that the oxygen content test may be safely omitted. The oxygen content must always be tested. Oxygen contents less than 19.5% may cause drowsiness and /or injury and death.

If analysis of the gas inside the transformer tank indicates that the atmosphere is not breathable (as noted above), it must be purged. Use a supply of known breathable dry air with a dew point of a minimum of -50°C (-60°C preferred).

CAUTION

Do not bubble air through residual oil in the bottom of the tank as this will produce undesirable oil vapour.

Pure oxygen is not acceptable, due to hazards involved.

Check to see if any items require protection to prevent damage during purging. It may be necessary to connect some items, such as tap changers, to the main tank to equalize pressures between them. In the case of other items, such as sealed conservator tanks, pressure relays, etc. it may be necessary to isolate them. The nameplate will indicate the maximum positive and negative pressures for which the tank itself is designed.

The space may be purged by admitting breathable dry air near the top of the space, and exhausting it near the bottom. This process should be continued until the oxygen content of the exhausted gas meets or exceeds 19.5%.

Alternatively, purging may be accomplished by evacuating the space to a vacuum of 10 mm Hg, then admitting breathable dry air to a slight positive pressure. Take samples from near the bottom of the space to verify that the oxygen content meets or exceeds 19.5%.

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DESCRIPTION – OPERATION - MAINTENANCE INSTRUCTIONS OBTAINING SAMPLES OF INSULATING OILS

A.S.T.M. Standard D-923, "Standard Methods of Sampling Electrical Insulating Liquids" should be followed when obtaining insulating oil samples for the measurement of dielectric strength, moisture content, and power factor. Note: this method is not suitable for obtaining oil samples where a measure of dissolved gas is required. For this purpose, A.S.T.M. Standard D-3613 should be observed.

The following is a summary of some of the major items involved in obtaining a representative sample.

General Precautions:

It is imperative that precautions be taken to prevent contamination of the sample. Minute quantities of contaminants can greatly affect the test results.

Since oil is lighter than water, the sample should be taken from the bottom of the transformer tank or oil container. For the same reason, containers in which oil is received should be allowed to stand in the sampling position for a minimum of eight hours before samples are taken.

Because of the hygroscopic tendency of insulating oil, it is necessary to minimize the exposure of the sample to the atmosphere. To minimize absorption of moisture, the oil should be at least as warm as the surrounding air. It is undesirable to take samples when the relative humidity is above 75%, and/or when the temperature is near or below 0° C. Do not take samples during periods of rain or snow.

Containers:

Clean glass bottles are the preferred container. Tin cans may be used for the samples but they must be free from rust, flux, or other contaminants.

Stoppers:

Stoppers may be of the following:

- a) Airtight ground glass stoppers.
- b) Cork stoppers, faced with tin, aluminum foil, or oil resistant plastic.
- c) Screw caps having paper board liners, faced with tin, aluminum foil, or oil resistant plastic.

Rubber stoppers must not be used.

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Cleanliness:

The cleanliness of the sample container and the sampling apparatus are vital to the integrity, and therefore the usefulness, of the sample. Articles should be chemically cleaned, thoroughly dried, and then stored in a warm dry, dust-free environment until used. Care must be taken not to touch any part of the apparatus which will come in contact with the liquid being sampled.

Seals should not be broken, and stoppers should not be removed from containers until ready to receive the sample. Glass stoppers may be re-used, provided they are chemically cleaned and thoroughly dried. The other forms of closures should not be re-used.

Methods:

One typical method of sampling from drums or similar containers involves the use of a dip-type sampling tube, or "thief". The sampling tube is inserted into the container so that the lower end of the tube is just below the surface of the oil, the upper end of the tube being closed by the thumb. The thumb is then removed and the tube lowered into the oil allowing the oil to flow into the bottom of the tube and fill it to the desired level.

The upper end of the tube is again closed with the thumb, and the tube now containing oil is withdrawn. The first quantity thus taken should be regarded as a washing for the tube and should be thrown away.

The sampling tube is again lowered into the oil container, this time until it touches the bottom of the container. The thumb is then removed so that the tube is filled with oil from the bottom of the container. The upper end is again closed with the thumb, and the tube now containing oil withdrawn and its contents transferred to the sampling vessel. This operation is repeated until the sampling vessel is full, and the latter is then immediately closed and sealed.

There are a number of methods of obtaining samples from sampling valves or petcocks on the transformer or reactor equipment, using hoses, bleed type or syringe type devices. In general, these require that the valve or cock be thoroughly cleaned before any oil is removed. Sufficient oil must then be drawn off to make sure that the sample taken is representative of the oil in the tank at the level of the valve. As in the case of the "thief", the sampling apparatus and vessel should be rinsed with the oil being sampled.

A typical method of obtaining samples from equipment involves the use of a glass hypodermic syringe, to which is attached a three-way stopcock. If the following procedure is adhered to, and the sample kept in the syringe, the samples may be used for all tests, including tests for measurement of dissolved gases.

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Remove the sampling valve cover and plug if present and drain about 1 liter of oil to scrap oil container to flush the sampling valve of the transformer. Attach the syringe to the sampling valve using a short length of polytetrafluoroethylene tubing. Open the syringe stopcock to permit flushing of the stopcock and tubing by moving the handle toward the syringe.

Note: The handle of the plastic stopcock always points to the closed port, leaving the other two ports in open communication (Fig.1).

Slowly turn the stopcock to the open position (Fig.2, handle in line with the flushing port) and allow 45 to 50 cm³ of oil to enter the syringe. Immediately close the stopcock (handle to the syringe) and separate from the tubing, allowing the oil to continue flowing through the tubing to the scrap oil container.

With the syringe vertical (Fig.3, stopcock up, handle away from syringe) eject any air bubbles and depress carefully the syringe piston to expel oil from the syringe. Close the stopcock (handle toward the syringe).

The syringe, bubble-free and with its dead space filled with oil, is now ready to be connected to the tubing (Fig.4) with oil flowing through the flushing port.

Slowly turn the stopcock to the open position (Fig.2, handle in line with the flushing port) and allow the oil pressure to force the piston back until the piston is filled approximately $\frac{3}{4}$ full. Do not pull the piston manually since this could result in bubble formation.

Close the stopcock (Fig.4, handle towards syringe) and separate it from the tubing and inspect for air bubbles. If air is present, discharge the oil with the syringe vertical (stopcock up) and then obtain another sample. Close sampling valve.

Note: Bubbles may form after sampling but, provided the sample was bubble-free initially, this will not affect subsequent analysis, if the total sample, including the bubble, is used. Do not attempt to remove these bubbles. To avoid bubble formation after sampling, apply continuous positive pressure to piston by means of rubber band or spring.

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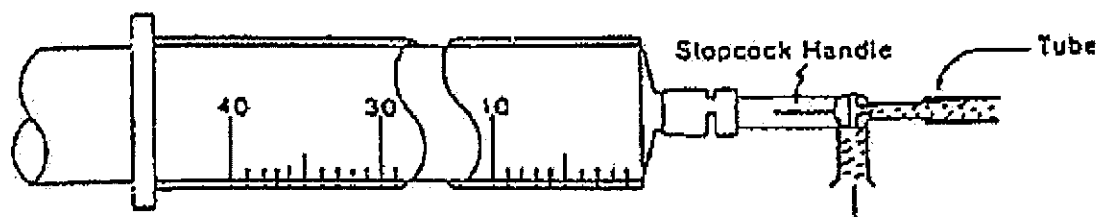


Figure 1. Stopcock with Two Open Ports

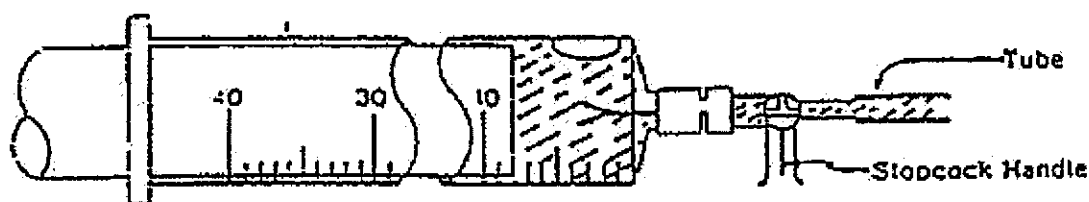


Figure 2. Stopcock with Handle in Line with Flushing Port

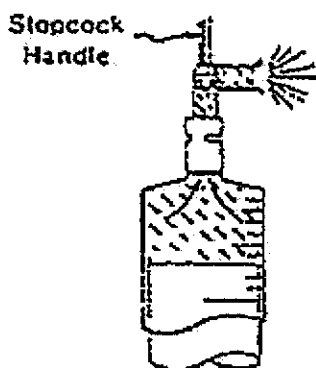


Figure 3. Stopcock Up, Handle Away from Syringe

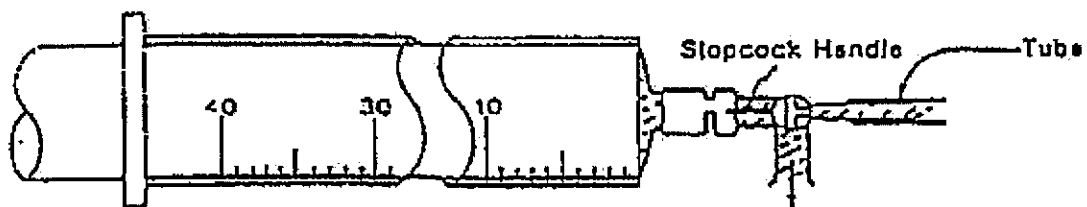


Figure 4. Stopcock with Handle towards Syringe

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DESCRIPTION – OPERATION - MAINTENANCE INSTRUCTIONS TOUCH UP PAINT

Transformers are often shipped partially assembled and they always require handling by either jacking and rolling or lifting with a crane. The units are secured for transportation by chains, welded supports or tie braces. The assembly, moving and shipping operations normally cause damage to some of the painted surfaces. In order to prevent rust and corrosion these damaged areas require touch up painting.

The following are instructions to touch up the damaged painted areas:

Preparation:

- ♦ Examine the paint finish, particularly around welded joints, on accessory items recently installed such as the radiators, coolers and associated piping, all areas where lifting tackle has been used or where jacking has taken place.
- ♦ Remove all detrimental foreign matter such as oil, grease, dirt, soil, salts, and other contaminants from the effected areas using a cloth and a solvent such as varsol, denatured alcohol, acetone or paint thinners.
- ♦ When the area is dry in approximately 15 minutes, remove all rust, scale and loose paint by either scraping, wire brushing or sanding, then wipe clean with a clean dry cloth. Make sure all paint gloss has been removed from the surface areas to be touched up.

Types of Paint:

Transformers are normally painted with either an Alkyd or Epoxy paint.

- ♦ Alkyd primer and paint are used directly from the containers supplied with the transformer.
- ♦ Epoxy paint and primer are supplied with three separate components consisting of a base, catalyst and reducer. When epoxy is used the primer and paint will be supplied with mixing instructions.

Painting:

- ♦ **Spot Primer** – Apply one coat by brush application to all prepared areas. Allow a minimum of one-hour drying time before applying finish coat.
- ♦ **Finish Coat** – Apply one coat by brush application to all previously primed areas.

Maintenance:

The paint surface will naturally deteriorate in time and this may be accelerated with environmental conditions such as seacoast locations, near highways that are salted in the winter, windy areas with sandy dust particles, chemical atmospheres, etc. The paint surface should be inspected annually and any areas that are deteriorating or are rusty should be repainted as described above.

It is not uncommon for transformers to require repainting after several years of service. It is recommended that you employ the services of a painting specialist when it is necessary to repaint the complete unit.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Siemens Transformadores S.A de C.V.

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