



ABB Inc.
Small Power Transformers
2135 Philpott Road
South Boston, VA 24592
Instruction Book

PM-1000
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Liquid Insulated Padmount Transformers

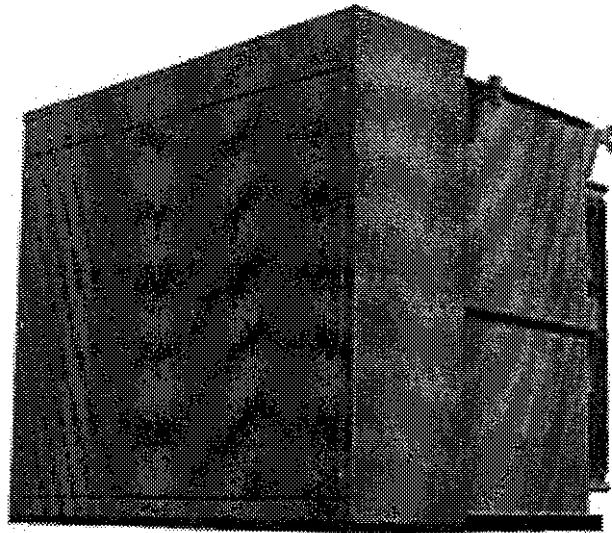


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READ THIS INSTRUCTION BOOK CAREFULLY BEFORE ATTEMPTING TO HANDLE, INSTALL, USE OR SERVICE THE TRANSFORMER. FAILURE TO FOLLOW INSTRUCTIONS COULD RESULT IN SEVERE INJURY, DEATH OR PROPERTY DAMAGE.

SAFETY NOTES FOR INSTALLATION AND OPERATION

DO NOT LIFT OR MOVE A TRANSFORMER WITHOUT ADEQUATE EQUIPMENT AND PRECAUTIONS.

TERMINALS ARE FOR ELECTRICAL LOADING ONLY, USE FLEXIBLE CONNECTORS TO AVOID MECHANICAL STRAIN.

DO NOT MAKE ANY CONNECTIONS THAT ARE NOT AUTHORIZED BY THE NAMEPLATE OR CONNECTION DIAGRAM.

DO NOT ENERGIZE TRANSFORMER WITHOUT PROPER GROUND CONNECTIONS.

DO NOT ATTEMPT TO CHANGE THE TAP SETTING WHILE THE TRANSFORMER IS ENERGIZED FROM EITHER H.V. OR L.V. SIDE.

DO NOT TAMPER WITH INTERLOCKS, ALARM AND CONTROL CIRCUIT.

IMPORTANT NOTICE: FAILURE TO OBSERVE THE REQUIREMENTS OF OSHA STANDARD 1910.269 CAN CAUSE DEATH OR SEVERE BURNS AND DISFIGUREMENT. THAT STANDARD SPECIFICALLY PROHIBITS THE WEARING OF POLYESTER, ACETATE, NYLON, OR RAYON CLOTHING BY EMPLOYEES WORKING WITH EXPOSURE TO ELECTRIC ARCS OR FLAMES.

The unit(s) covered by these instructions have been inspected and tested to meet all applicable standards of ANSI, NEMA, and IEEE, to assure you of the highest quality product.

The instructions in this manual should familiarize qualified personnel with the proper procedures to keep all new unit(s) in proper operating condition.

These instructions do not propose to cover all details or variations in equipment, or to provide for every contingency to be met in connection with installation, operation, or maintenance. Should further information be desired, or particular problems arise which are not covered, please contact the ABB Small Power Transformer Division South Boston factory.

1. INTRODUCTION

These instructions apply to liquid filled padmount transformers manufactured by the ABB Small Power Transformer Division at South Boston, Virginia.

The equipment covered by these instructions should be operated and serviced only by competent personnel familiar with good safety practices. These instructions are written for such personnel and are not intended as a substitute for adequate training and experience in the use of this equipment.

The transformer outline drawing shows the location of nameplates and warning signs. Read and follow all warning signs and nameplates installed on the transformer.

NOTE: DO NOT REMOVE OR COVER THE WARNING SIGNS AND NAMEPLATES.

Electrical characteristics, winding connections and weights are on the nameplate. Physical details, such as weights and dimensions are shown on the transformer outline drawing. Repair information for all parts is not included because replacement is recommended rather than repair. If information is desired in greater detail, copies of instruction leaflets referred to, but not included with this book can be obtained by contacting the ABB Small Power Transformer Division.

2. RECEIVING

NOTE: Inspection of transformer, packages and parts is required prior to unloading from carrier, in order to establish the condition of the equipment upon delivery.

2.1 Drawing and Documents

Shipping papers, packing list, outline drawings, this instruction book and other pertinent documents furnished with the transformer must be available for use during the inspection.

2.2 External Inspection

All transformers are carefully tested at the factory and are in good condition when shipment is made. If the inspection indicates a shortage, damage or evidence of hidden damage, it must be reported to the carrier's representative and to a representative of the ABB Small Power Transformer Division before unloading the transformer. As a minimum the following inspections should be made.

External Inspection Transformer Tank and Fittings

1. Is there any indication of external damage?
2. Is the paint finish damaged?
3. Are the attached fittings loose or damaged?
4. Is there evidence of fluid leakage on or around the tank coolers?
5. Are any of the bushings broken or damaged?
6. Is there any visible damage to the parts or packaging that shipped separately from the transformer?

2.3 Tank Pressure

The tank pressure may be positive or negative when received, depending on liquid temperature. In some cases, the vacuum pressure gauge may read zero, which could indicate a tank leak. In such cases, pressure test the tank according to the instructions in Section 6.3.1. Report tank leaks of new transformers to the ABB Small Power Transformer Division.

2.4 Detail Parts

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

The detail parts should be stored in a clean, dry area that will minimize exposure to weather and the possibility of damage or loss.

2.5 Internal Inspections

When a new transformer is delivered, an internal inspection is normally not required. Temporary shipping braces are not used inside the transformer. **No internal inspection should be performed unless authorized by ABB Small Power Division.**

3. HANDLING PRIOR TO INSTALLATION

3.1 Tilting

Transformers should be handled in the normal upright position, but in no case tilted more than 15° from vertical, unless instructions have been given to the contrary. Refer to the outline for these instructions.

3.2 Lifting

Lifting hooks or eyes are provided on the transformer tank wall. Only these hooks can be used in lifting the complete transformer. Refer to the outline for the proper lifting hook locations. All four lifting hooks must be used for proper handling. The weight of the padmount compartment may make the transformers front heavy. Therefore, the use of a lift beam caddy is recommended so that the center of gravity may be adjusted. Failure to adjust for the center of gravity may result in damage to the compartment.

3.3 Jacking

Refer to the transformer outline drawing for jacking areas on the transformer tank. Only those areas may be used when the transformer is jacked. **Note: When jacking the tank, assure that the jack does not come in contact with the radiators.**

4. STORAGE PRIOR TO ENERGIZING

4.1 Storage of Transformer

When storing the transformer, it should be completely assembled and pressure tested in accordance with Section 6.3.1. The terminal chamber compartment doors should be closed and locked to provide maximum protection for bushings, accessories and other components located within the chambers. The gas space above the liquid should be pressurized with dry nitrogen between two to three PSIG. This will aid in preventing moisture from being pulled into the tank during pressure variations caused by temperature changes.

Additional Tests and Inspections
1. Record ambient temperature and barometric pressure for correction of test data.
2. Pressure test to insure the tank and fittings do not have leaks. After test is complete, the pressure should be reduced to two (2) PSIG.
3. Test insulating liquid for dielectric strength and moisture content.
4. Test insulation with a 1000 or 2500 volt megger.
5. Check the insulation power factor using Doble or similar test equipment. Note: This test is not possible on a secondary with a solidly grounded neutral.
6. Test ratio in all tap positions to insure proper tap changer operation.
7. Verify liquid level by gauge reading.

4.2 Extended Storage Guidelines

Transformers stored for more than 60 days must adhere to the followed instructions.

1. Store the transformer on a firm level foundation, preferably at its installation site. Perform external inspections listed in Section 2.2 and the tests and inspections listed below.
2. The transformer should be completely assembled. The terminal chamber compartment doors should be closed and locked to provide maximum protection for bushings, accessories and other components located within the chambers.

If the transformer is provided with molded bushing wells, molded inserts or molded single piece bushings, a rubber cap is supplied for environment protection. These caps should be in place at the time of storage and should be checked during routine inspections to insure that it is not damaged or lost.

3. When the transformer can not be stored at its permanent location, the transformer must be placed on a level foundation suitable for the total weight.

4. Parts that are shipped separate from the transformer must be stored in a clean, dry area.

5. Space heaters, when supplied in switches, terminal chambers, control cabinets, or other cases, must be connected and energized at all times.

The following inspection must be made while the transformer is in extended storage. Record the results for comparison with previous data to insure that there has been no deterioration in the condition of the transformer.

Quarterly Inspection*

1. Check the protective materials covering the bushings to be sure they are in place and free of damaged. Replace if necessary.
2. Record gauge readings, including the ambient temperature and barometric pressure.

- a. Take a pressure reading. Compare with previous two (2) psig reading. Variances in barometric pressure must be taken into account.
- b. If the pressure or liquid level readings indicate a possible leak in the transformer, perform a pressure test according to Section 6.3.1. Any leaks should be repaired immediately.
- c. If a leak was found, perform the following;
 - Test insulation megger test.
 - Insulation power factor.

Refer to Section 6.3.3 for acceptable results.

**Perform the first inspection 30 days after the transformer has been put into storage and quarterly thereafter.*

Annual Inspection

1. Check the paint finish and touch up as necessary.
2. Test insulating liquid for dielectric strength and moisture content.
3. Test insulation megger test. Refer to Section 6.3.3.
4. Check the insulation power factor. Refer to Section 6.3.3.

When the transformer is taken out of storage, the pre-energization tests and inspections identified in Section 6.3 must be performed. Review the storage records of the transformer to insure that there has been no deterioration in the condition of the transformer.

ACCESSORIES AND COMPONENTS

5.1 Alarm Switch Ratings

Accessories supplied with transformer are shown on the outline drawing. When accessories have control wiring or are equipped with alarm contacts, refer to the control wiring diagram referenced, or the outline drawing, for contact type and ratings and terminal points.

5.2 Transformer Nameplate

A nameplate is supplied on each transformer according to ANSI standard C57.12.00. The nameplate provides basic information for use of the transformer.

5.3 Control Cabinet

Control cabinets and other wiring, when supplied, are located inside the padmount compartment.

WARNING: THE TRANSFORMER MUST BE TOTALLY DE-ENERGIZED BEFORE ATTEMPTING WORK IN THESE CONTROL CABINETS OR WIRING.

WARNING: THE CONTROL CABINET MAY CONTAIN SOME EQUIPMENT OPERATING AT HIGH VOLTAGES. ALWAYS REMOVE THE CONTROL CABINET OR WIRING VOLTAGE SUPPLY PRIOR TO PERFORMING WORK INSIDE THE CONTROL CABINET EQUIPMENT OR CONNECTED ACCESSORIES. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Refer to the wiring diagram for electrical circuits. Use an indicating light type device when checking an alarm switch. Failure to do so could result in damage.

5.4 Current Transformers

WARNING: CURRENT TRANSFORMER SECONDARIES MUST BE CONNECTED TO A LOAD OR SHORT-CIRCUITED TO AVOID DAMAGING VOLTAGES AT THE TERMINALS. FAILURE TO MAKE THESE CONNECTIONS COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Current Transformers are optional accessories. They are mounted inside the transformer tank around the transformer line leads. When the bushing is on the tank wall, the current transformer may be mounted on top of the core and coil assembly. Current transformer secondary leads are always wired to padmount transformer compartment. Refer to the wiring diagram to identify the wire codes. The current transformer secondary leads are always short-circuited and grounded to the tank when the transformer is shipped.

5.5 Liquid Level Gauge

The liquid level indicator indicates the liquid level inside the tank. The tank is filled at the factory to the level that corresponds to a liquid temperature of 25° C. When the liquid is at a temperature other than 25° C, use Table 1 to determine the variation above or below the normal level before adjusting fluid level. The indicator is shipped mounted on the transformer tank and requires no maintenance other than the periodic inspection recommended in Table 4 of this Instruction Book.

Average Liquid Temperature (°C)	Correct Level (Percent of Scale Above or Below 25 °C Level)
85 (high)	100
70	75
55	50
40	25
25 (Normal)	0
10	-33
-5	-67
-20 (Low)	-100

Contact factory if liquid level gauge does not agree with Table 1.

5.6 Liquid Temperature Gauge

The temperature gauge, when supplied, is furnished to indicate the top liquid temperature in the tank. The temperature sensitive element is mounted in a dry, leak-proof well, permitting removal of the thermometer without lowering the liquid level.

WARNING: THE TRANSFORMER MUST BE TOTALLY DE-ENERGIZED BEFORE ATTEMPTING TO REMOVE THIS GAUGE.

The device is furnished with a red pointer to show the highest temperature attained since last reset. To reset the maximum indicator, rotate the magnet at the center of the dial or, on some models, past the reset button.

WARNING: THIS DEVICE MUST BE RESET WITH A HOT-STICK OR THE TRANSFORMER MUST BE TOTALLY DE-ENERGIZED BEFORE ATTEMPTING A MANUAL RESET.

During normal operations the liquid temperature gauge should read less than the sum on the ambient temperature and the rated temperature rise. For example, 30°C ambient + 55°C rated temperature rise = 85°C top oil temperature.

5.7 Pressure-Vacuum Gauge

WARNING: WHEN THE PRESSURE-VACUUM GAUGE READS ZERO AND DOES NOT CHANGE UNDER ANY TRANSFORMER LOAD, THE TRANSFORMER SHOULD BE CHECKED FOR POSSIBLE LEAKS. A LEAK WILL ALLOW MOISTURE AND AIR TO ENTER THE TRANSFORMER, WHICH COULD DEGRADE THE INSULATION AND FLUID AND POSSIBLY CAUSE A FAILURE.

The pressure-vacuum gauge, when supplied, indicates the tank gas space pressure relative to atmospheric pressure. Maintenance is not required except for the periodic inspection recommended in Table 4 of this instruction book.

5.8 Pressure Relief Device and Relief Valves

WARNING: NEVER DISASSEMBLE A PRESSURE RELIEF DEVICE. DISASSEMBLY COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE FROM HAZARDOUS FLYING OBJECTS.

Some transformers are furnished with a pressure relief device on the transformer cover under a tamper proof housing. Other transformers may have relief valves that are located within the padmount compartment.

The pressure relief device or valves will vent tank gases when excessive tank pressure exists. The device consists of a self-resetting, spring-loaded diaphragm and a mechanical operation indicator (Semaphore). The maximum tank pressure at which the pressure relief device will remain sealed is stamped on the relief device nameplate. Should the tank pressure increase above the pressure relief device nameplate rating, the gas pressure will lift the diaphragm, vent the excess pressure, and trip the Semaphore.

Immediately after the pressure returns to normal, the diaphragm will reset and reseal the transformer. This event is not normal. If the semaphore indicator is lifted, the cause of the operation should be investigated. The mechanical operation indicator (semaphore) must be reset manually after each operation. The pressure relief device will withstand full vacuum and need not be removed from the transformer tank during any vacuum.

The relief valve is a spring loaded, self-resetting valve stem fitting. As the pressure increases above the valve rating, the stem will move relieving the pressure. The relief valve can also be used to manually relieve the tank pressure.

WARNING: WHEN USING THE RELIEF VALVE TO RELIEVE TANK PRESSURE, A HOT FLUID MIGHT BE EXPELLED. EYE AND SKIN PROTECTION MUST BE USED TO AVOID PERSONAL INJURY.

5.9 Winding Temperature Gauge

This optional device is also known as a Dial Hot Spot Thermometer. It simulates the hottest spot temperature of the transformer windings by sensing both the surrounding liquid temperature and a current source that is proportional to the load current. The sensing stem is mounted in a dry well, permitting its removal without lowering the fluid level. A red pointer is furnished to show the highest temperature attained since last reset. Rotating the magnet that is located on the dial face can reset this pointer.

Should a check on accuracy and calibration be desired, obtain additional information from ABB Small Power Transformer Division.

Maintenance is not required except for the periodic inspection recommended in Table 4 of this instruction book.

5.10 De-energized Tap Changer

WARNING: DO NOT MOVE THE TAPCHANGER POSITION, UNLESS THE TRANSFORMER IS TOTALLY DE-ENERGIZED. FAILURE TO DO SO WILL RESULT IN THE FAILURE OF THE TRANSFORMER AND COULD RESULT IN SEVERE PERSONAL INJURY OR POSSIBLE DEATH.

The de-energized tap changer is provided as means to adjust the transformer voltage to closely match that of the user system voltage. It is not to be used as a means to regulate the secondary voltage. If the tap changer is used in this manner, it will result in high noise level and higher no-load losses and possible core saturation. Refer to the transformer nameplate for the tap voltages possible for the transformer.

The de-energized tap changer is provided with an operating handle, tap voltage position indicator and a position locking mechanism. Some de-energized tap changers may have provisions for a pad locking or a Kirk Key Interlock System.

Usually, the transformer is shipped in the rated voltage position. To change the tap voltage position, follow these steps:

1) DE-ENERGIZE THE TRANSFORMER

2) Disengage the position lock. This is done one of three ways, depending upon the tap changer used:

A. When a locking pin is provided, pull the pin out and turn the operating handle.

B. When the locking provisions are in the operating handle, pull the handle straight out beyond the indicator plate, then turn the handle; or

C. When the model is locked in place by a small bolt, back the bolt out until it is passed the indicator plate, turn the handle to the new position.

3) Move the operating handle to the desired tap position. The tap voltage indicator plate identifies the tap position. On some models, the operating handle must be rotated 360° to engage the next position. Other models require only short movement to the next position indicator.

4) Re-engage the position lock. Only when the tap changer is in the correct position, can the position lock be engaged. **DO NOT ENERGIZE THE TRANSFORMER UNLESS THE POSITION LOCK IS FIRMLY IN PLACE.**

5.11 Bushings

WARNING: EXTERNAL CONNECTIONS MUST NOT EXCEED A CANTILEVER LOAD OF 100 POUNDS. GREATER LOADS MAY CAUSE BUSHING DAMAGE THAT COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Generally, the secondary and primary bushing are factory installed and require no maintenance except as described in Table 4 of this instruction book. When special bushings are provided instruction bulletins will be provided with the transformer. Contact the factory if additional information is required.

5.12 Surge Arresters

Arresters are provided on some transformers when specified. Usually, the arresters that are mounted external to the tank are shipped detached from the transformer to avoid damage.

WARNING: TO PREVENT SURGE ARRESTER DAMAGE, FOLLOW THESE INSTRUCTIONS. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

A) When installing the arrester, all mounting feet must be flush before tightening bolts. Shim if necessary.

B) The arrester must not be climbed or stood on.

C) Use only the lifting devices provided on the arrester for lifting.

D) Arrester port exhaust, if supplied, must be directed away from protected equipment and other arrester poles.

E) Poles must be made of the serial numbered units identified on the master nameplate (located on the bottom of the arrester unit).

F) Maximum cantilever force is 100 pounds for intermediate and SMX Station Surge arresters. Distribution type arresters are not to be mounted in a cantilever mode.

Transformers may be furnished with Intermediate Class, Station Class, or distribution type surge arresters as optional items. These arresters are shipped separately in a protective carton or crate. On receipt, unpack the units and examine for breakage or other damage, especially to the porcelains. Check the parts with the packing list.

5.13 Other Accessories and Components

Padmounted transformer accessory and component instructions not included in this document, where applicable, will be provided separately in accompanying documentation.

6. INSTALLATION

6.1 Location and Mounting

Transformer must be placed on a foundation of sufficient strength to support the weight of the unit. The foundation must be level within one half inch per 100 inch base. If the unit is not level, the liquid may not circulate through all the cooling tubes and cause overheating that will shorten the transformer life. When a transformer is designed for tilt while energized, the degree of maximum tilt will be noted on the transformer nameplate. The location of the transformer should provide for adequate accessibility, ventilation and ease of inspection for the unit. To assure proper air circulation for cooling, the transformer coolers should be at least 24 inches from any obstruction. Location in areas of corrosive chemicals should be avoided.

6.2 Opening Transformer Tank

Transformers are generally shipped sealed and need not be opened. An exception to this is when delta-wye and series-multiple connections are made using an internal terminal board. These connections are accessible through a handhole located on the cover. When entry is required read and follow the instructions given below.

Likewise, when access is required for damage inspection or other problems, the following precautions should be followed. **Note: Contact the factory for assistance and directions when damage is suspected or other problems exist. Observe the safety precautions that follow.**

WARNING: RELEASE INTERNAL PRESSURE PRIOR TO REMOVING TANK ACCESSORIES WITH A PRESSURE SEAL (MANHOLES, RELIEF DEVICE, PLUGS). FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

Internal pressure may be relieved by use of gas sample valves; or by SLOWLY removing the filling cap a thread at a time until the pressure starts to relieve itself.

WARNING: TO AVOID DEATH FROM SUFFOCATION NEVER ALLOW ANYONE TO ENTER THE TRANSFORMER TANK UNLESS AN ANALYSIS OF THE AIR IN THE TANK SHOWS AT LEAST 19.5% OXYGEN. THE GAS SPACE ON AN OPERATING TRANSFORMER CONSISTS OF NITROGEN GAS. WHENEVER ANYONE IS IN THE TANK, A PERSON SHOULD BE STATIONED AT THE MANHOLE OUTSIDE THE TANK TO INSURE SAFETY OF THE PERSON INSIDE.

Safety Precautions for Opening A Tank

When it is necessary to open a transformer, the following procedure should be used. Ventilate the gas space with dry air to purge it of the nitrogen gas that it contains.

Dry air should be used to ventilate the inside of the tank when it is opened for internal fitting. When dry air is used, the following restrictions should be observed:

- a. Temperature of dry air entering the transformer shall be at least as high as that of the transformer and at least 10°C higher than the dew point of the outside air.
- b. Dry air shall be blown into the transformer so as to create a flow of air through the cover opening. Air hoses may be taken into the transformer if they are clean and made from an oil-proof material.
- c. The dew point in the transformer should never be higher than 20°F.

d. Dry Air and Nitrogen. When nitrogen is called for, the nitrogen used should have a dew point not higher than -50°C (-58°F), and total impurities not exceeding 0.1% by volume. Nitrogen can be obtained in high-pressure steel cylinders, or in some locations in insulating low-pressure containers in liquid form. In general, liquid nitrogen that will boil in the container to yield gaseous nitrogen will have a lower dew point than gas in high-pressure cylinders.

Dry air should also have a dew point of -50°C (-58°F) or lower. It is usually available in cylinders from the nitrogen supplier. Air drying equipment is also available which is capable of producing dry air by passing air through a desiccant bed to remove moisture.

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

Outside air may be used for ventilating the transformer if dry air is not available. If outside air is to be used for ventilation, open the transformer only if the outside relative humidity is less than 65% and if the temperature of the transformer is at least 10°C higher than the dew point of the outside air.

The maximum total time the transformer should be open is 24 hours. If this time must be exceeded, extend the length of the vacuum prior to filling specified in Table 7 by one hour for each 4 hours that the open time exceeded 24 hours. If work is interrupted, the tank should be closed, evacuated, and refilled with dry air or nitrogen.

Do not open the transformer in an area unprotected from weather during precipitation or in an area where the air may contain dirt or other particles. Either of the above could cause a transformer failure. If the transformer is opened, the openings should be protected from the entry of foreign matter into the transformer tank at all times. It may be necessary to remove some liquid from liquid-filled units for adequate inspection.

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

Never stand directly on any electrical insulation. Clean drop cloths should be used under working areas in the transformer to prevent objects from dropping into the structure.

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

One person should be responsible for policing the people and materials into and out of the tank and for making certain that nothing is left in the tank accidentally. This person should also be responsible for limiting the length of time the tank is left open to 24 hours.

After the tank has been opened the following tests should be made.

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

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

3. When accessible, disconnect the core ground connection on core form transformers and measure the resistance from the core to the tank or end frames, using a 1000-volt megger. The resistance should exceed 100 megohms, if the core is not covered with liquid, or 200 megohms, if the core is under liquid. When the internal inspection is complete, reseal the tank and refill the gas space with dry air or dry nitrogen.

6.3 Preparation for Energization

The following are instructions that must be followed when preparing the transformer for energization. These instructions provide minimum requirements to determine the transformer's readiness for service. Check off each section as it is completed.

6.3.1 () Pressure Test

Prior to energizing the transformer, check the integrity of the transformer tank. Introduce dry air or dry nitrogen through the pressure test fitting (this may be identified as the air test valve or a gas sampling valve on the transformer outline) until a positive internal pressure of 3 to 4 psig is established. Allow the tank to stand for one to two hours, then examine the tank and fittings for leaks. A leak above the liquid level can be located by applying a soap solution to all joints, pipe fittings and other devices that penetrate the tank wall. When the pressure test is complete, reduce the internal pressure to 1 or 2 PSIG.

6.3.2 () Insulating Liquid Test

Before energizing the transformer, the liquid must be tested in accordance with Section 8. The dielectric strength of new liquid must be 26 KV or higher.

6.3.3 () Insulation Megger Test

To insure that no grounding of the windings exists, a 1000-volt megger test and a power factor test should be made. Refer to Table 2 and 3 for allowed values of insulation resistance.

L-L Voltage Class KV	Megohms
1.2	32
2.5	68
5	135
8.66	230
15	410
25	670
34.5	930
46	1240
69	1860

Transformer Temperature °C	Correction Factor	Transformer Temperature °C	Correction Factor
95	89.0	35	2.5
90	66.0	30	1.8
85	49.0	25	1.3
80	36.2	20	1.0
75	26.8	15	0.73
70	20.0	10	0.54
65	14.8	5	0.40
60	11.0	0	0.30
55	8.1	-5	0.22
50	6.0	-10	0.16
45	4.5	-15	0.12

6.3.4 () Ratio Test

A ratio test should be made at all tap positions to insure proper transformer ratios and tapchanger connection.

6.3.5 () Continuity, Resistance Test

There should be a continuity check of all windings. If possible, measure the winding resistance and compare to the factory test values. An increase of more than 10% could indicate loose internal connections.

WARNING: DO NOT CHANGE CONNECTIONS ON A TRANSFORMER THAT IS ENERGIZED NOR MAKE ANY CONNECTIONS EXCEPT AS AUTHORIZED BY THE NAMEPLATE OR CONNECTION DIAGRAM. TO DO SO WILL RESULT IN SEVERE PERSONAL INJURY, DEATH, OR PROPERTY DAMAGE.

6.3.6 () Connections

When electrical connections are made:

() a. all mating joints must be clean and connections must be tight. All electrical connections must be to the correct terminal and be mechanically secure. Check the following items:

() b. Line connections must be made without placing undue stress on the bushings per Section 5.14.

() c. Check that the tap changer operating mechanism is in the proper position for the required voltage.

() d. If the transformer is equipped with an internal terminal board that requires opening the transformer tank, read Section 6.2 for instructions and warnings prior to opening tank.

Delta-wye and Series - multiple connections are made using an internal terminal board or a de-energized switch. Make the connection-according to the chart on the transformer nameplate. Terminal board connections must be mechanically tight to prevent overheating of the joint.

() e. The transformer tank must be grounded permanently by connecting a ground cable per the National Electric Code to a ground pad located at the bottom of the tank.

6.3.7 () Wiring

Make a physical examination of control circuit wiring and alarm devices, if provided. Look for damaged insulation, and loose connections.

6.3.8 () Liquid Level

Liquid level should be at the correct level according to Table 1.

WARNING: THE TRANSFORMER MUST HAVE THE CORRECT LIQUID LEVEL BEFORE ENERGIZING THE UNIT (REFER TO TABLE 1). FAILURE TO DO SO COULD RESULTING SEVERE PERSONAL INJURY, DEATH OR PROPERTY DAMAGE.

6.3.9 () Tank Finish

All damaged paint surfaces should be cleaned, primed, and repainted.

6.3.10 () Bolt Check

Tighten all external bolts.

6.3.11 () Tools

All tools or other objects used in installation are accounted for and have been removed from the transformer.

6.3.12 () Liquid Temperature

The liquid temperature must be no lower than -20°C when the unit is energized. The liquid temperature gauge can be used for this determination.

After the inspections and tests in Sections 6.3.1 through 6.3.12 are completed and any required repairs have been made, the transformer may be energized.

7. REPAIR MAINTENANCE

WARNING: ALWAYS DE-ENERGIZE THE TRANSFORMER WHEN WORKING ON THE TRANSFORMER. FAILURE TO DO SO COULD RESULT IN SEVERE PERSONAL INJURY DEATH, OR PROPERTY DAMAGE.

7.1 It is the responsibility of the owner to inspect, maintain, and keep the transformer in good repair.

7.2 Report all failures during the warranty period to the ABB Small Power Transformer Division. All warranty repairs must be made or approved by the ABB Small Power Transformer Division.

7.3 The core and coil assembly can be repaired or replaced by authorized ABB personnel. Contact the ABB Small Power Transformer Division.

7.4 Tank leaks must be repaired immediately to prevent serious damage to the transformer and danger to life. Request Instruction Leaflet 48-069-20 for detailed instructions on tank repair.

7.5 The following periodic test and inspections are recommended as routine maintenance.

Check Period	One Month After Initial Energizing	Once A Year After Energizing
7.5.1 Gauge Readings	X	X
7.5.2 Tank Leaks		X
7.5.3 Control Wiring and Circuits		X
7.5.4 Paint Finish		X
7.5.5 Liquid Dielectric Test		X
7.5.6 Temperature Scan Bushing Terminal and Surface	X	X
7.5.7 Insulator Cleanliness Inspection		X

7.5.1 The gauge readings should be recorded as well as the ambient temperature and the KVA load. Any abnormal reading as explained in Section 5 is justification to make other diagnostic test or inspections immediately.

7.5.2 If pressure or liquid level readings give cause to suspect a leak make a pressure test in accordance with the instructions and warnings of Sections 6.3.1

7.5.3 The control wiring should be checked for integrity of insulation: The conduit and control cabinet should be inspected to assure that weather resistant seals are intact. Control power supply voltage should be checked with respect to the wiring diagram.

7.5.4 Inspect the paint finish for scratches or wear that expose the prime coat or the tank steel itself. Any paint damage must be repaired to prevent base metal corrosion or further deterioration of the paint surface. Contact the factory for repair instructions, if needed

7.5.5 Liquid Dielectric Test. It is recommended that a liquid sample be taken periodically and tested. The dielectric strength of the liquid should not drop below 26 kV. Refer to Section 8.

7.5.6 Using an infrared scanner, check the bushings terminal temperatures. A loose or dirty connection would be indicated by an excessive bushing terminal temperature. (NOTE: Bushing temperature will be approximately 10°C hotter than liquid temperature when transformer is at rated kVA). If the transformer is not energized, the bushing terminal connections should be checked to ensure that they are tight. Loose connections will cause excessive conductor temperatures.

7.5.7 Bushing and surge arrester insulators (porcelain, epoxy) should be clean. If the surfaces are excessively dirty, they should be cleaned while the transformer is not energized.

7.6 If additional instructions are needed, contact the factory.

8. SAMPLING OF INSULATION LIQUID

Care should be taken to procure a sample that fairly represents the liquid in the tank. A quart of liquid should therefore be drawn off before the sample is taken to insure that the sample will not be that which is stored in the sampling pipe. If the sample taken contains free water, it is not suitable for dielectric tests and the sample should be discarded. A second sample should then be taken after at least two quarts of liquid have been withdrawn. If free water still exists, the liquid should be run through a blotter filter press and re-tested for dielectric strength.

The sample of the liquid should be taken when the unit is warmer than the surroundings to avoid condensation and should also be taken only on clear days. When sampling oil from the transformer, the sample must come from the bottom of the tank.

When sampling SILICONE FLUID from the transformer, the sample may come from either the top liquid level or the bottom of the tank.

It is recommended that a 16-ounce amber glass container be used as a sampling receptacle so that any water present may readily be seen. Do not use rubber gaskets or stoppers on SILICONE FLUID sample bottles.

Additional information concerning handling, sampling, filtering, testing and reconditioning can be obtained by ordering Instruction Book 45-063-100 for OIL, and Instruction Book 45-063-102 for SILICONE FLUID through the ABB Small Power Transformer Division.

