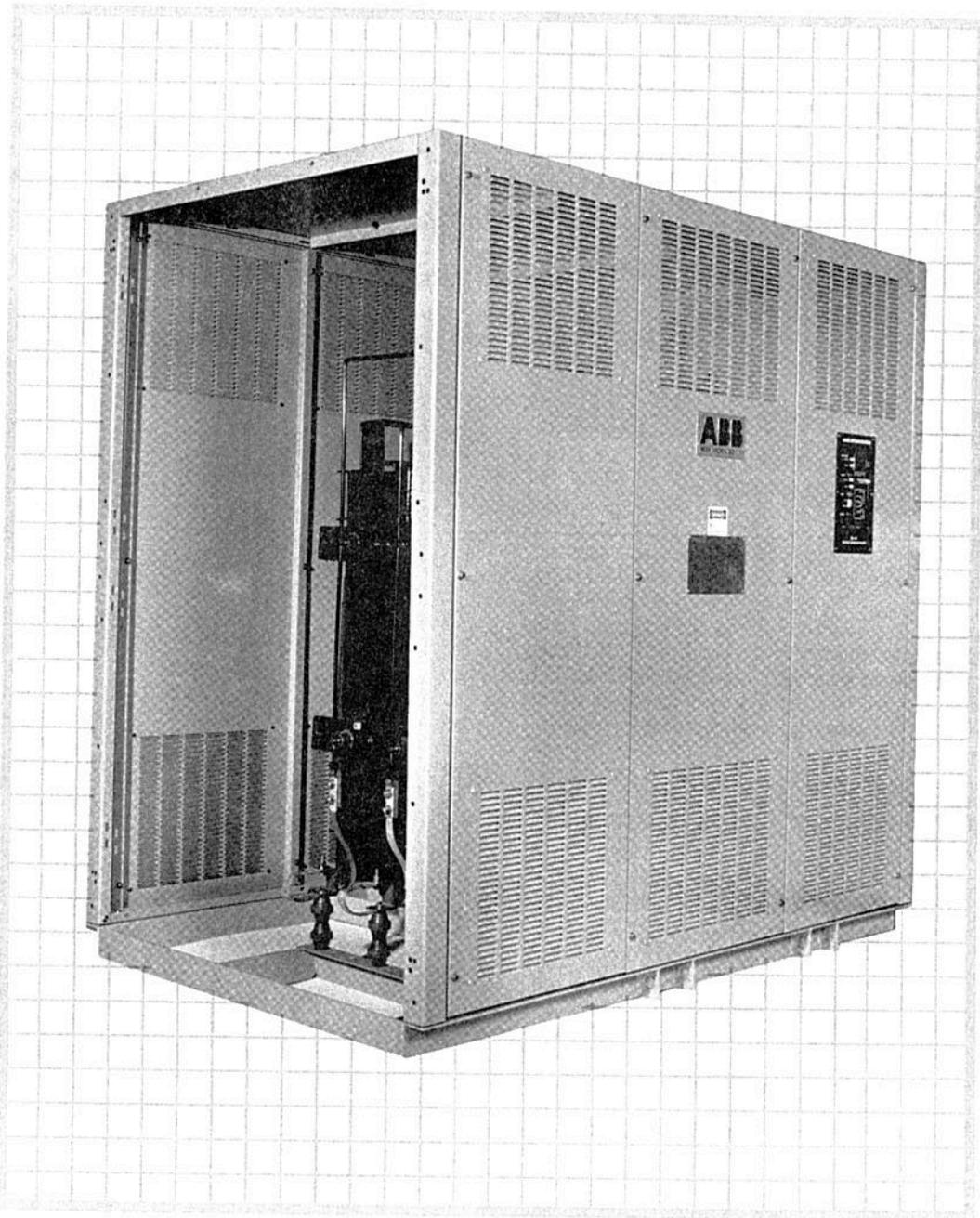


# Installation/Maintenance Instructions

## Indoor Dry Type Transformers

**Conventional and VPE  
112½ thru 10,000 KVA**



### SAFETY NOTES FOR OPERATION

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

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

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

DO NOT ENERGIZE TRANSFORMER WITHOUT PROPERLY MADE GROUND CONNECTIONS.

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

DO NOT CHANGE CONNECTIONS OF A TRANSFORMER THAT IS UNDER EXCITATION.

DO NOT TAMPER WITH INTERLOCKS, ALARM AND CONTROL CIRCUIT.

DO NOT REMOVE COVER PLATES OR ACCESSORIES WHILE THE TRANSFORMER IS ENERGIZED.

The unit(s) covered by these instructions have been repeatedly inspected and tested to meet all applicable standards of ANSI, NEMA, and IEEE, to assure you of a first-rate quality product, which should give many years of satisfactory performance.

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, nor 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 factory.

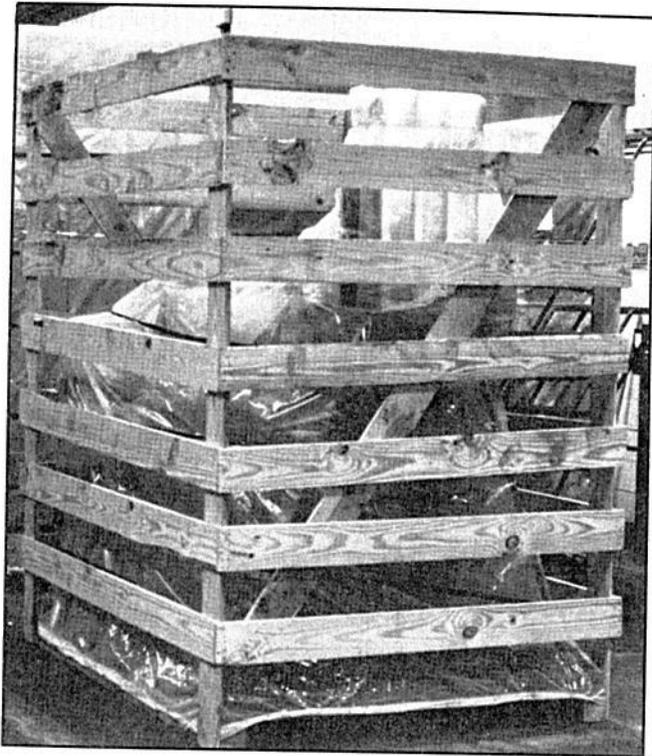
**RECEIVING**

**Inspection and Acceptance**

**CAUTION CAUTION CAUTION CAUTION**

It is very important that a thorough inspection of each unit be made prior to its acceptance and removal from the carrier's vehicle. All discrepancies should be noted on the Bill of Lading.

Ventilated dry type transformers are shipped either completely assembled in a sheet metal enclosure or as a core and coil assembly and are covered with a clear plastic sheet to prevent entrance of moisture and dust. All units are packaged and shipped to meet the requirements of ANSI Standards N45.2.2, "Packaging, Shipping, Receiving, Storage and Handling of Items for Nuclear Power Plants." When units are shipped as a core and coil assembly with a knocked-down enclosure, a drawing will be included in the document package to assist in assembling the enclosure.

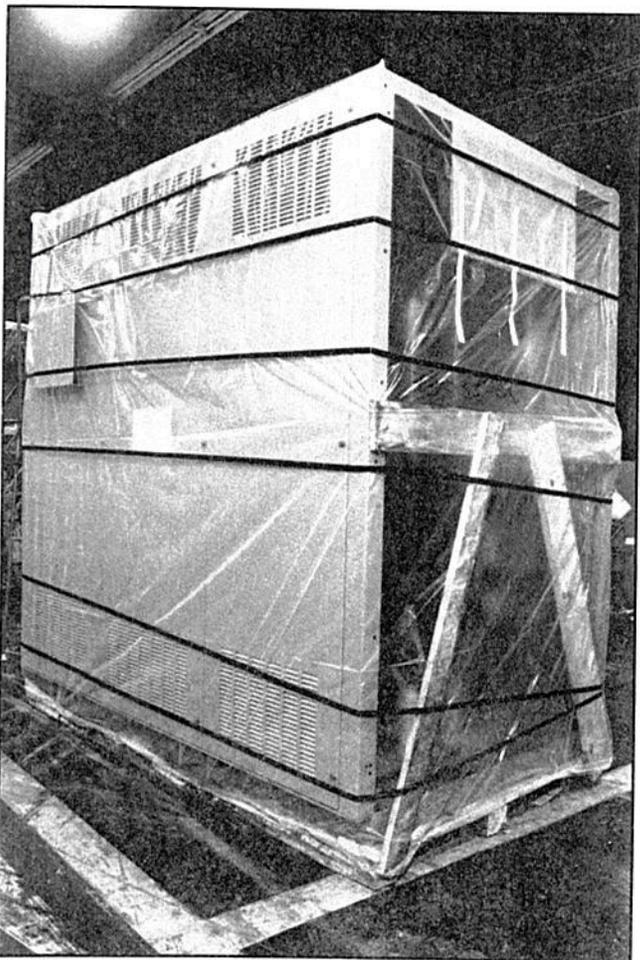


**Typical crating and cover for a core and coil assembly**

For your convenience, a representative check list of areas which should be checked prior to acceptance from the freight carrier is as follows:

- Does the nameplate serial number agree with the packing list and Bill of Lading identification?
- Is the unit damaged due to mishandling?
- Are the accessories damaged any way?
- Winding temperature indicator (if applicable)
- Fan motors and blades (if applicable)
- Lightning arresters (if applicable)
- Is there damage to the enclosure?
- Louvers
- Front or back panels
- Are parts damaged which were shipped separately?

If damage is detected or shortages are noticed, write a brief description on the Bill of Lading. It is the customer's responsibility to file a claim with the carrier. If, however, the unit has been shipped FOB jobsite, notify the factory.



**Typical packaging for an Enclosed-Indoor Ventilated Dry Transformer**



Recommended loading and unloading by forklift

## HANDLING

All efforts should be made to avoid handling a dry type transformer during inclement weather. If it becomes necessary to do so, adequate protection against rain, snow and excessive dust should be provided. If a unit has been exposed to moisture during handling or storage, it must be carefully inspected and tested prior to energization to determine if drying is necessary. See page 8 for appropriate instructions for drying out and testing such a unit.

**WARNING WARNING WARNING WARNING**

Possible core and coil assembly shifting may occur while in transit. The bolted connection between the core and coil assembly and base may shift up to 1½". The hole provided for this connection is of an oval shape to allow for adjustment. Upon receipt of the unit, a dimensional check of bus locations should be made prior to installation of the unit to its switchgear assembly. If, due to core and coil shift, proper alignment cannot be achieved, contact the factory for the appropriate method of rectifying the problem.

## Core and Coil Assemblies

Assemblies are shipped on wooden pallets and surrounded by wooden crating suitable for moving with a forklift truck. Should a forklift truck not be available, all units have lifting

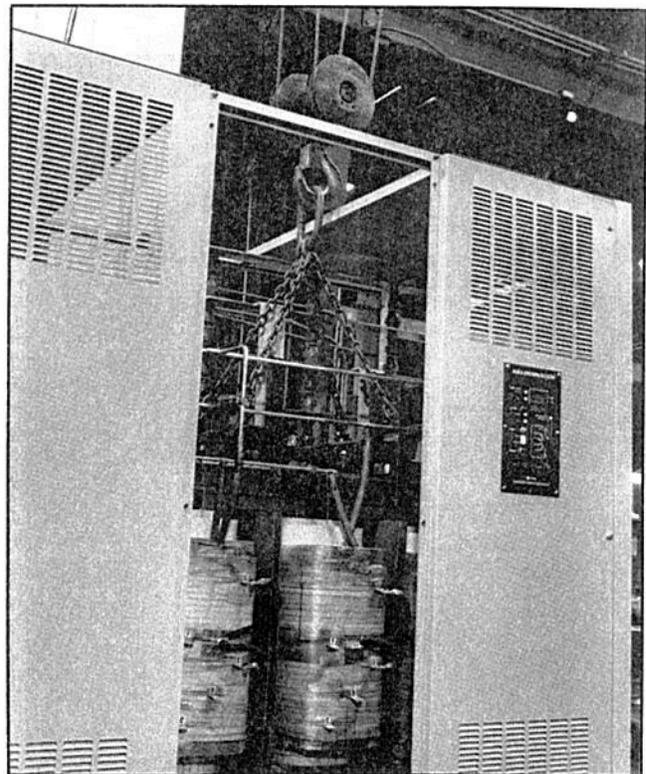
eyes provided on the core and coil assembly. These should be used when moving the core and coil assembly by an overhead crane.

## Complete Transformers

Assemblies are preferably moved by forklift truck. If the unit is lifted by the external lifting means, care should be taken to avoid damage to the enclosure by allowing at least 20 feet from the top of the enclosure to the lift hook or by using a spreader bar. Removal of the enclosure top cover allows easy attachment of shackles to the welded lifting eyes on the top core clamp for crane lifting.

**CAUTION CAUTION CAUTION CAUTION**

Cable pull angles should not exceed 30° from vertical. Avoid tilting unit is top heavy.



Recommended method of lifting from overhead Storage

Always store dry type transformers indoors in a clean, dry location free from corrosive vapors and mechanical injury. The ambient temperature should be constant. Core and coil assemblies and the ventilated openings on their enclosures should remain covered with the clear plastic wrap used at time of shipment to keep out dirt, dust and moisture from the surrounding area.

For extended storage, consideration should be given to installing space heaters, thermostatically controlled, to prevent condensation on the core and coils.

**WARNING WARNING WARNING WARNING**

Before energizing or placing any unit into service after extended storage, a check of the insulation resistance should be made, by megger test. Drying out of the unit may be necessary.

(Space heaters are not adequate for drying.)

## INSTALLATION

A clean, flat surface capable of supporting the transformer unit weight is the only requirement for a foundation. It is, however, important that adequate accessibility, ventilation and ease of inspection of the unit be provided. Although the unit must only have a 24" clearance from any obstruction for proper ventilation, to obtain the average sound levels equivalent to factory test levels, a 10' clearance on all sides is recommended.

Care should be taken to insure that the cooling air is clean, dry, free from dust, metallic particles and corrosive vapors and gases for all indoor transformers. The room air inlets should be located at floor level and outlets as high as the room will allow. The flow of air should be directed across the unit.

**CAUTION CAUTION CAUTION CAUTION**

10 sq. feet of both inlet and outlet area should be provided for each 1000 KVA of transformer rating or approximately 100 CFM per kilowatt of loss.

Standard transformer unit ratings are designed, based on an average daily ambient of 30°C with a maximum intake of air not to exceed 40°C at any time, and to operate up to altitudes of 3300 feet above sea level. Before operating a standard design transformer in higher ambient air or at higher elevations, please contact the factory for appropriate derating factors.

## SOUND LEVELS

All transformers have an inherent sound level that varies with the size of the units. The fundamental frequency is twice that of the applied voltage.

Sound waves may be amplified by means of reflected waves and/or radiated waves via walls, floors, ceilings, mechanical vibrations of air ducts, conduits and mounting bases.

For average expected sound levels, refer to NEMA ST-20.

**CAUTION CAUTION CAUTION CAUTION**

To meet NEMA listed average sound levels, each unit should be installed in a location where there is a 10' clearance on all sides except floor or ground. Units located in close proximity to hard surfaces may produce higher than average sound levels. When transformers must be located in noise sensitive areas, precautions should be taken to avoid amplification of the transformer sound.

Install the unit in an area where the noise will be least objectionable. Avoid rooms where hard surfaces are in close proximity of the transformer.

Use acoustic absorbing materials on walls, floors and ceilings.

Avoid installation of units in corners, hallways, stairways and near heating and air conditioning ducts.

## Reduction of Structureborne Noise

Remove anchor bolts between the transformer and enclosure and let the unit rest on the vibration pads only. (Except on certified seismic units.)

Use flexible conduit and bus connections.

Avoid mounting the unit on walls, balconies and floors with low masses. Avoid uneven mounting surfaces.

## CONNECTIONS

**WARNING WARNING WARNING WARNING**

A poor ground may result in loss of life or damage to the equipment. An effective low resistance ground is essential for proper protection.

Each ventilated dry transformer must be permanently grounded by connecting an effective recognized ground as prescribed by the latest applicable NEC requirements.

If the transformer is designed to operate with a solidly grounded neutral system, the neutral connection should be solidly and permanently grounded.

The transformer core structure has an internal electrostatic ground between the core and coil assembly and base structure. This point should also be connected to either a ground bus within the substation or by cable to a substation ground grid.

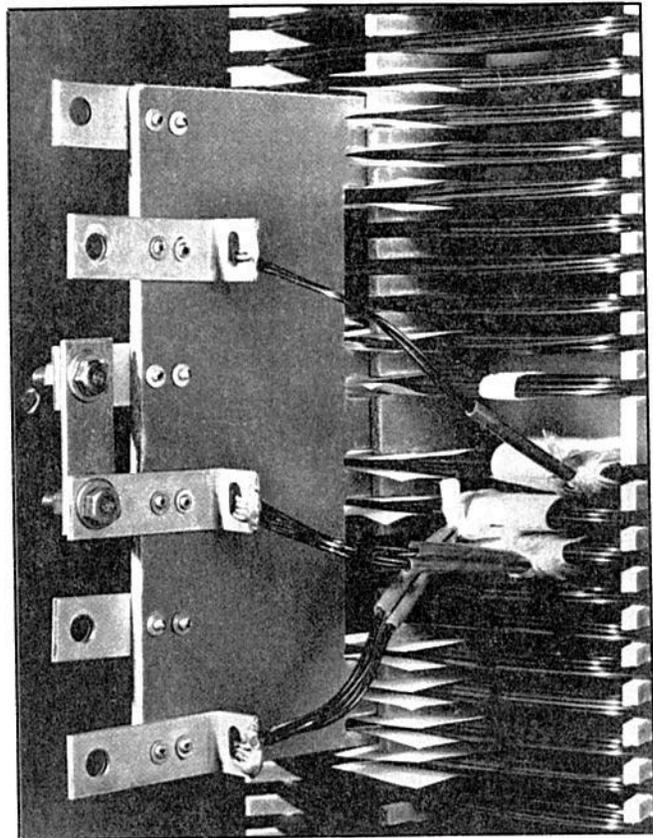
### Tap Connections

**WARNING WARNING WARNING WARNING**

Tap connections may be changed only when the transformer is totally de-energized.

Standard units have taps located on the face of each H.V. winding. The tap arrangement is shown on the nameplate. These taps are provided to furnish rated output voltage when the input voltage differs from the rated voltage.

To change tap connections, de-energize the transformer, short circuit both the high and low voltage connections and ground both sides. Remove front panel of case for access to taps. Next, loosen and remove the nut on the tap on the front of the H.V. coil. Remove the tap jumper connection and move the connection to the desired tap on each phase. All coils must have identical tap connections. Remove safety shorts and ground connections from the H.V. and L.V. buses. After assuring that no tools or hardware were left in the enclosure, replace the front panel of the enclosure and re-energize the transformer. Make sure that the tap connections are proper for the required voltage as listed on the nameplate. Assure that all coils are connected at identical taps. The transformer is normally shipped with the tap connections made for rated voltage.



**Random Wound Tap Connections**

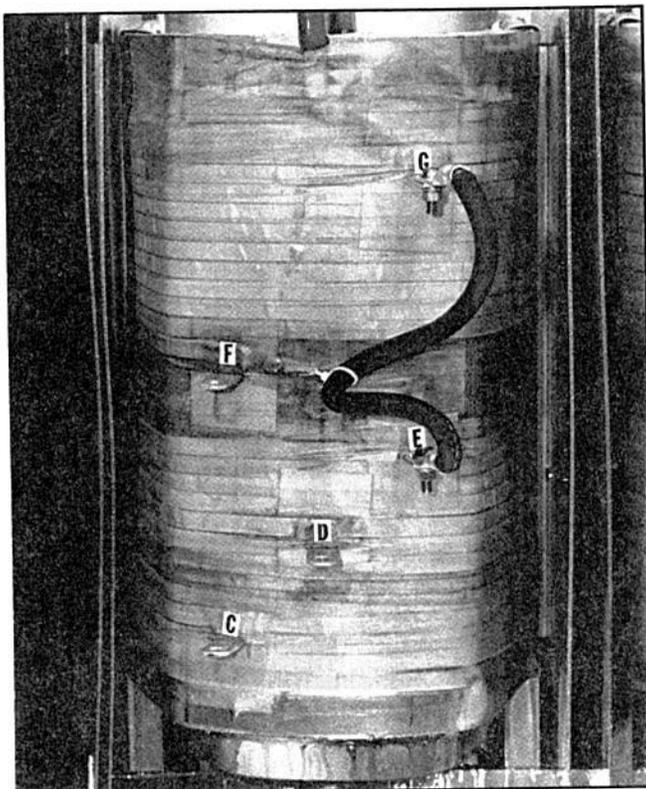
**NOTE: For series multiple windings, taps are only available on the highest winding voltage in the series connection.**

### Cable Connections

When outside cable connections are required, conductors suitable for at least 90°C (194°F) should be used. Minimum clearances at terminals should be maintained in accordance with the following table.

Transformer Voltage Class	Minimum Clearance (in.)
1.2kV	1.0'
2.5kV	2.0'
5.0kV	2.5'
8.7kV	3.5'
15.0kV	5.0'
18kV	6.0'
25kV	8.0'
35kV	11.5'

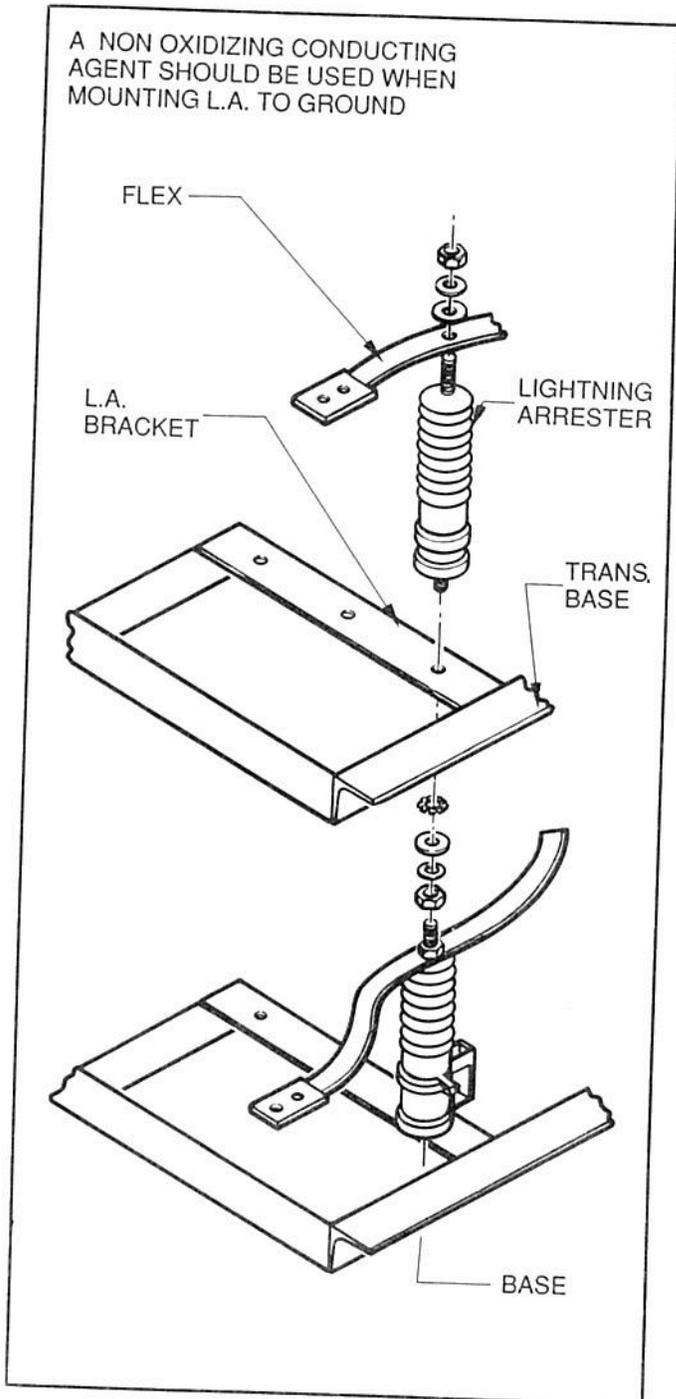
All connections should be made without placing undue stress on the terminals. Conductors should be securely fastened in place and adequately supported with allowances for expansion and contraction.



**Layer Wound Tap Connections**

## Lightning Arresters

At times, it becomes necessary to ship the specified lightning arresters loose to the jobsite, due to physical size and/or to prevent shipping damage. See drawing below for proper method of installation.



Typical Lightning Arrester Installation

## Bus Connections

When connecting the transformer unit to other high voltage or low voltage switchgear assemblies, make sure all connection points are clean and connections tight. It should be noted that all aluminum connections as well as taps are plated to assure low resistance connections.

## FINAL INSPECTION PRIOR TO ENERGIZATION

Before energizing the unit, a complete electrical and mechanical inspection should be made. The following check list should be used as a minimum requirement:

### Electrical Inspection

- All external connections have been made properly. (Phasing of connections to terminals, etc.)
- All connections are tight and secure.
- All accessory circuits are operational.
- All tap connections are properly positioned.
- The neutral and ground connections have been properly made.
- Fans - if supplied - are operational
- Proper clearance is maintained at terminals as outlined under "Connections."
- Proper clearance is maintained from high voltage and low voltage bus to thermal equipment.
- The correct transformer ratio exists for units with internal terminal boards.
- All windings are free from un-intended grounds. A 500 volt megger test is recommended. See section under "Resistance Measurement," page 8.
- There is continuity in all windings.

### Mechanical Inspection

- There is no dust, dirt, or foreign material on the core and coils.
- There is no visible moisture on or inside the core and coils (and enclosure).
- All plastic wrappings are removed from the core and coils.
- All shipping members have been removed
- There are no obstructions in or near the openings for ventilation.
- No tools or other articles are left inside of, or on top of, the core and coils or enclosure.
- All protective covers are closed and bolted tight.

## OPERATION

**WARNING WARNING WARNING WARNING**

Never operate a dry type transformer without protection coverings or panels. Never probe with long objects through ventilation grilles or remove protective panels when the transformer is energized. Injury or death may result, as well as damage to the equipment.

Make periodic temperature checks to assure that the transformer does not operate for any length of time above its rated load and temperature.

Normal humidity in the air has little effect on dry type transformers which are energized.

If a shutdown occurs during a period of low humidity, no special precautions are necessary before re-energizing the transformer. However, under conditions of high humidity, precautions must be taken to assure that there is no condensation inside the transformer. Space heaters (optional) placed inside the housing should be energized to provide protection against this condition. As a simple rule, always keep the transformer a few degrees above ambient temperature.

## DRYING OF VENTILATED DRY TRANSFORMERS

In order to remove moisture from a transformer that has been exposed to high humidity, spray, or extended storage, the following methods are recommended:

1. Applications of external heat:  
External heat is applied by passing heated air through the inlets in the bottom of the transformer housing. Direct the air so that it passes through the winding ducts and not only around the sides of the coils. Adequate ventilation is essential during this process. The most effective way to apply external heat is to place the core and coil assembly into a well-ventilated oven.
2. Heating by circulation of current:  
Heating by circulation of current is accomplished by short circuiting the secondary terminals of the transformer and applying impedance voltage to the primary terminals. This will produce 100% rated current in all windings. To obtain the impedance voltage multiply nameplate impedance times primary voltage noted on the nameplate.

The heating process should be continued until an insulation test gives satisfactory results.

**WARNING WARNING WARNING WARNING**

In no case should the windings exceed 150°C at the hottest measurable spot while applying the circulating current method.

## USE OF INSULATION RESISTANCE FOR DETERMINING DRYING TIME

Drying time depends on the condition of the transformer, size, voltage, amount of moisture absorbed and the method of drying used.

The measurement of insulation resistance is of value in determining the status of drying. Take measurements before starting the drying process and at two (2) hour intervals during drying. The initial value, if taken at room temperatures may be high even though the insulation may not be dry. Keep the temperature of the transformer approximately constant during the drying period, to obtain comparative readings.

As the transformer is heated, the presence of moisture will be evident by the rapid drop in resistance measurements. Following this period, the insulation resistance will generally increase gradually until near the end of the drying period when it will increase more rapidly. Sometimes it will rise and fall through a short range before steadying, because moisture in the interior of the insulation is working out through the initially dried portions. A curve with the time as abscissa and resistance as ordinate can be plotted. Continue the drying until the resistance levels off and remains relatively constant for from three (3) to four (4) hours.

Before taking insulation resistance measurements, the transformer should be de-energized and the winding should be short circuited and grounded for at least one (1) minute to drain any static charge. All readings should be taken at the same time of application of the test voltage, preferably one (1) minute.

Insulation resistance measurements should be taken in this order:

- A) Primary to ground with secondary grounded.
- B) Secondary to ground with primary grounded.
- C) Primary and secondary to ground.

If winding resistance is used in determining winding temperature, contact the factory to obtain the needed information.

## ACCESSORIES

### Winding Temperature Equipment

Depending upon customer preference, units can be provided with devices for either single-phase or three-phase temperature indication. Either device will consist of a digital or analog temperature indicator and thermal sensor(s).

The indicator is mounted on a control panel located on the front of the transformer enclosure. Installation of thermal sensors will be completed at the factory. The indicator is calibrated to read the hot spot temperature of the transformer in °C.

A 120 or 240 AC single-phase power supply is required to operate the indicator. For wiring and auxiliary contact setting, please refer to the connection diagram and instructions furnished with each unit.

**WARNING WARNING WARNING WARNING**

**BEFORE ENERGIZING TRANSFORMER, VERIFY MINIMUM ELECTRICAL CLEARANCES (PER THE TABLE ON PAGE 6) AND PROPER MECHANICAL SUPPORT OF TEMPERATURE INDICATOR CONTROL WIRING AND SENSORS. FAILURE TO DO SO COULD RESULT IN DAMAGE TO THE EQUIPMENT AND DANGER TO OPERATING PERSONNEL.**

### Transformer Cooling Fans

When fans or blowers are installed on a transformer it is necessary to check the fan control system and to determine that air delivery is being made to the transformer coils.

### Space Heaters

If the transformer is to be held in storage or will undergo periods of de-energization, it is recommended that space heaters be used to prevent accumulation of moisture on the core and coil assembly. The space heaters are 120 volt-150 watt, and are thermostatically controlled. Heaters are mounted directly beneath the coils, front and back, on brackets attached to the bottom core clamps. Two (2) heaters are used per coil with three (3) heaters on the HV side and three (3) on the LV side. Space heaters are provided with a terminal block for connection to an external power source.

## PERIODIC INSPECTION AND MAINTENANCE

**CAUTION CAUTION CAUTION CAUTION**

Do not use a pressurized air line for cleaning due to the possibility of blowing debris into the windings which could be abrasive and damage the winding insulation.

Due to many varied environmental conditions where ventilated dry type transformers are installed, a periodic inspection and maintenance program should be instituted to keep your unit(s) in operating condition.

Dust accumulation on the enclosure grilles or louvers is an indication that an internal inspection should be made. To make this inspection and to clean the core and coil assembly, the following steps should be adhered to:

1. De-energize the transformer. Never remove front or rear panels while the unit is energized.
2. Ground unit for one (1) minute to drain static charge.
3. Remove front and rear panels. Using an industrial vacuum cleaner, clean the louver and grille area.
4. Use the industrial vacuum cleaner to remove dirt and dust from the core, coils, insulators and remaining structures.

When insulation resistance is used as a maintenance test it should be performed in accordance with C-57.12.91. "Test Code for Dry Type Distribution and Power Transformers." The insulation resistance of dry type transformers is a function of the winding design and the types of material used in the insulation system, and are subject to considerable variations due to temperatures, humidity, and other environmental conditions. The test should be made with the transformer at ambient temperature and isolated from other equipment. If lightning arresters are supplied they should be disconnected prior to making the insulation resistance test. In general, for a cold transformer, readings of the high voltage windings to ground should be at least 100 megohms, but never less than 2 megohms per KV of the high voltage rating.

## RENEWAL PARTS

Replacement accessories may be ordered through the factory. Should you require parts or service, give a complete description of the part, serial number as listed on the nameplate of the problem to the ABB representative.





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