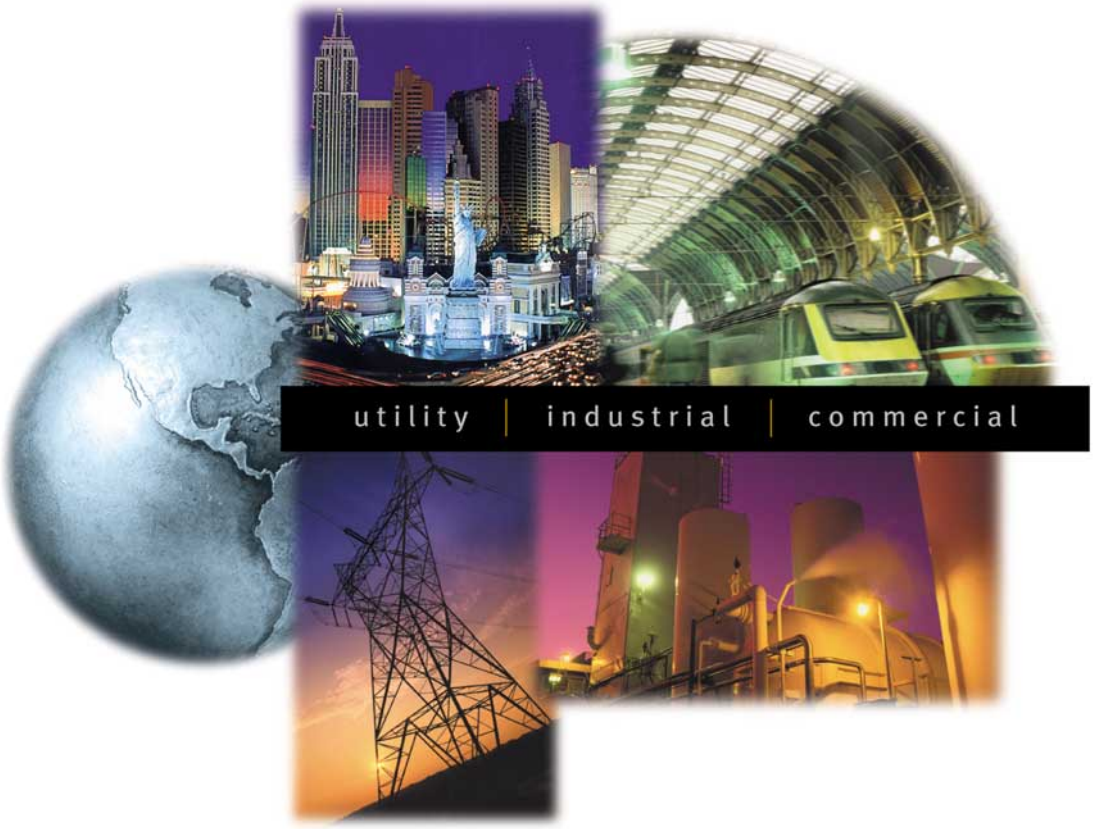
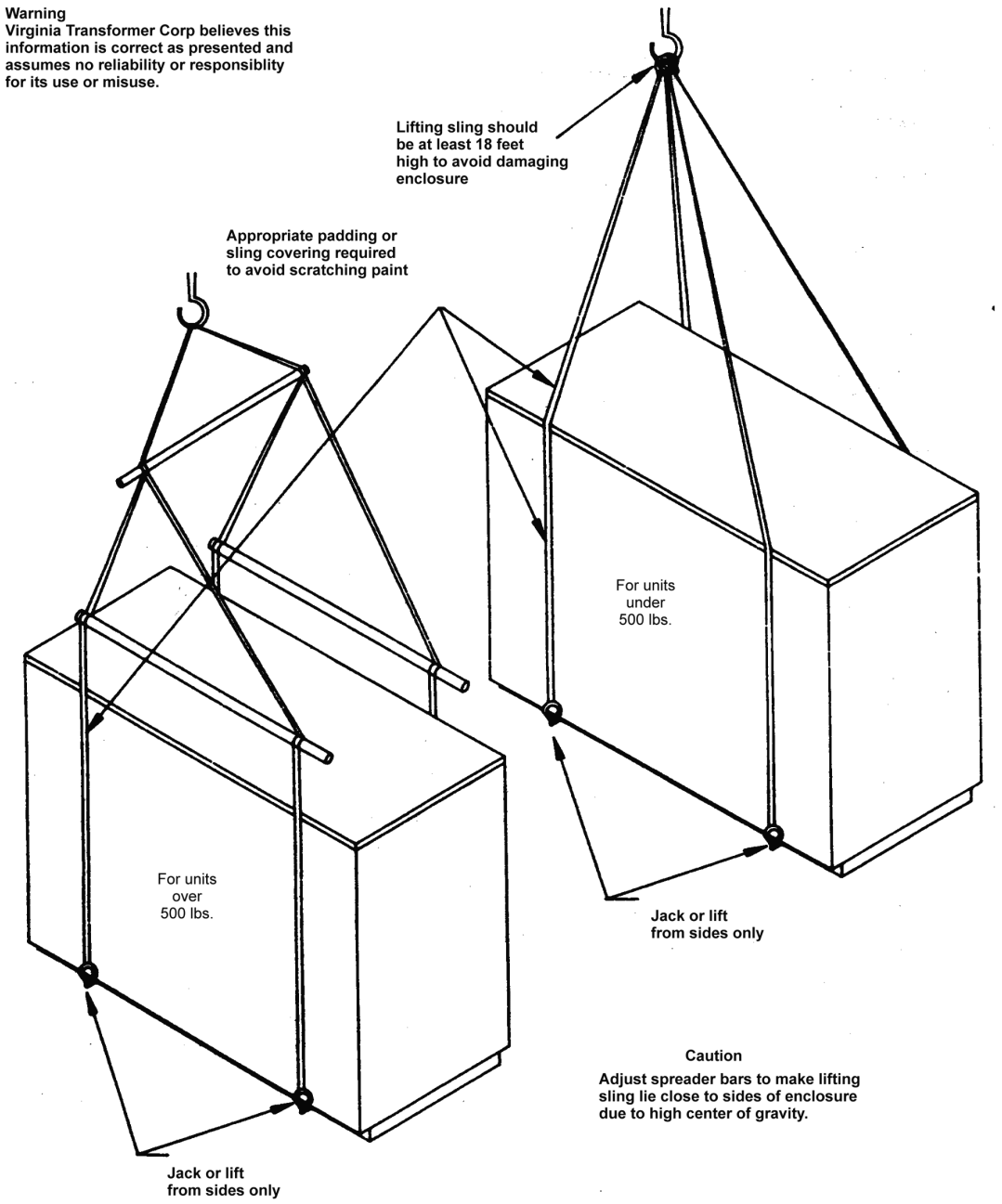


Instructions for

Receiving, Installing, Operating and Maintaining Dry Type, VPI Sealed, Cast Coil and UNICLAD® Transformers

220 Glade View Dr.◆ Roanoke, VA 24012 USA
Phone (540) 345-9892 ◆ Fax (540) 342-7694
Visit us at www.vatransformer.com



Dry-type Transformer Lifting Procedure

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Table Of Contents

The information contained herein is believed to be accurate and reliable. However, the supplier assumes no responsibility for its use or misuse and warns the reader to exercise caution in the installation and maintenance of the products described herein.

Please read the entire document before following any part of it.

Megger Reading Per Section 4.1 And Date Of Energization Must Be Sent To Supplier Within 15 Days Of Energization For Warranty To Be Valid.

1.0 General

This manual addresses general considerations for the operation and maintenance of dry type distribution and power transformers.

The successful operation of these transformers is dependent on proper installation, loading, and maintenance, as well as on proper design and manufacture. Dry type transformers require little maintenance as compared to other types of transformers, but appropriate attention will ensure their expected service life. Conditions of operation determine the extent of maintenance required. A periodic inspection program should be established to monitor the effects of the conditions on the transformers.

In addition to this guide, the manufacturer should be consulted for recommendations on special conditions.

Portions of the following information are reprinted from ANSI Appendix C57.94 Guide for installation and Maintenance of Dry-Type Transformers.

WARNING: Lethal Voltages will be present inside all transformer enclosures and at all connection points. Installation and maintenance should be performed only by personnel qualified and experienced in high voltage equipment. De-energize the transformer before performing any maintenance or service work.

2.0 RECEIVING

2.1 Inspection

When received, new transformers should be inspected for damage during shipment. Examination should be made before removing them from cars or trucks; and, if any injury is evident or any indication of rough handling is visible, a claim should be filed with the carrier at once and the manufacturer notified. Subsequently, covers or panels should be removed and an internal inspection made for damage or displacement of parts, loose or broken connections, dirt or foreign material, and for the presence of water or moisture. If the transformer is moved or if it is stored before installation, this inspection should be repeated before placing the transformer in service.

2.2 Handling

The transformers are designed with provisions for lifting, jacking, or rolling. These provisions will vary in detail depending upon the weight, size and mechanical configuration of the unit. The weight distribution should be studied by examining the inside of the transformer. Spreader bar must be used in order not to crush the enclosure.

Enclosed transformers with lifting lugs on the enclosure may be lifted with appropriate slings or chains. Larger units will have provisions for lifting from the base frame of from the top core clamps. Lifting from base frame may require use of spreader bar to avoid damage to the enclosure panels. (See illustration, opposite page 1)

Units lifted from the top core clamps will sometimes require that the tot) cover or part of the cover be removed. Rigging crew must be experienced in lifting and moving of heavy electrical equipment.

CAUTION: Dry type transformers should be maintained in an upright position when being moved. No attempt to handle a transformer in any other position should be made without first contacting the manufacturer.

Because of their high center of gravity, dry type transformers are subject to tipping over during handling. Care during handling will prevent equipment damage and/or personnel injury.

Core and coil units should be lifted using only the lifting device/holes provided on the core clamps. Care should be taken to prevent damage to bus work, wiring and termination assemblies during lifting. When lifting, increase tension gradually; do not jerk, jar or otherwise move the transformer abruptly.

If the transformer cannot be lifted by a crane, it can be skidded or moved on rollers. Care should be taken not to damage the base or tip it over. When rollers are used on transformers without structural base, skids should be used to distribute the stress over the base.

Large enclosed units with base frame type enclosures, may be jacked using the base frame angles. The transformer should be jacked evenly on all four corners to prevent warping or tipping over. Units wider than 66 inches must be jacked at the lifting lugs only.

Care must always be taken to prevent any foreign material from falling into or onto the coils. Hardware, connecting parts, tools, or any foreign material should not be allowed on top of the core and coil assembly. Foreign material lodged in a coil duct can cause electrical failure or overheating.

3.0 Installation

3.1 Location

Major factors to be considered when locating dry type transformers are: personnel safety, accessibility, ventilation, atmospheric conditions, and sound level.

When planning the installation, a location should be selected that will comply with all safety codes, and will not interfere with the normal movement of personnel, equipment, and material. The location should not expose the transformer to possible damage from cranes, trucks, or moving equipment. It should be remembered that damage to the enclosure may reduce the insulation clearances to an unsafe level.

As an added safety precaution, thought should be given to the possibility of personnel inserting rods, wire, etc., through the ventilation openings of the enclosure and thus coming into contact with live parts. Transformer ventilation openings are designed in accordance with NEMA standards, which require that 1/2" diameter rod cannot be inserted through the ventilation openings.

The installation will be simplified if an outline drawing is requested. By studying the overall, mounting and terminal dimensions, it is possible to plan the installation with an orderly arrangement of connections.

Core and coil units (without enclosure) usually have mounting and terminal dimensions to suit the customer's enclosure. That enclosure should give protection to the coils and have adequate clearance

and sufficient ventilation openings. The manufacturer should always be consulted to determine these requirements. Top covers may be designed for cable entry or exit with bolt-on cover plates; NOTE, that conduits, bus ducts, etc., must be independently supported as top cover is not designed for these loads. Ventilated dry type transformers can be designed for installation indoors or outdoors. They will operate successfully where the humidity is high, but under this condition it may be necessary to take precautions to keep them dry if they are shut down for appreciable periods. For locations where severe atmospheric conditions prevail, Totally Enclosed Non Ventilated (TENV), UNICLAD® sealed coils, or cast coil transformers are recommended.

Locations where there is dripping water should be avoided. If this is not possible, suitable protection should be provided to prevent water from entering the transformer case. Precautions should be taken to guard against accidental entry of water, such as might be obtained from an open window, by a break in a water or steam line, or from use of water near the transformers.

CAUTION: Adequate ventilation must be provided for Dry Type air-cooled Transformers.

Adequate ventilation is essential for the proper cooling of these transformers. Clean dry air is desirable. Filtered air may reduce maintenance if the location has a contamination problem. When transformers are installed in vaults or other restricted spaces, sufficient ventilation should be provided to hold the air temperature within established limits when measured near the transformer inlets. This usually will require approximately 100 cubic feet of air per minute per kilowatt of transformer loss. The area of ventilation openings required depends on the height of the vault, the location of openings, and the maximum loads to be carried by the transformers. For self-cooled transformers, the required effective area should be at least one square foot each of inlet and outlet per 100 KVA of rated transformer capacity, after deduction of the area occupied by screens, gratings, or louvers.

Ventilated dry type transformers should be installed in locations free from unusual dust or chemical fumes. Transformers should be located at least 12 to 18 inches away from walls and other obstructions

that might prevent free circulation of air through and around each unit, unless the unit is designed for wall mounting and installed per factory recommendations. Also, accessibility for maintenance should be taken into account before locating the transformer. If the transformer must be located near combustible materials, the minimum separations established by the National Electrical Code and local Fire Marshall should be maintained.

The transformer enclosure is designed to prevent the entrance of most small animals and foreign objects. However, in some locations, it may be necessary to give consideration of additional protection.

3.2 Sound Level

Special consideration should be given to the installation of any transformer if noise is a factor in its location and operation. Many locations can result in an amplification of the sound level. For example, if the transformer is installed in a quiet hallway, a definite hum will be noticed. If the unit is installed in a location it shares with other equipment such as motors, pumps or compressors, the transformer hum will go unnoticed.

Data given here is for guideline only. The 24 hours average temperature in the room should not exceed 30 °C, and the Maximum temperature is 40 °C. The transformer is designed to produce a minimum sound level when the following directions are followed:

A. Connections to primary and secondary terminals made with flexible connectors;

B. All transit bolts and shipping braces loosened so unit will float on rubber isolation pads.

C. All enclosures hardware tightened so panels do not vibrate.

3.3 Inspection

Once the transformer has been located on its permanent site, a thorough final inspection should be made before any assembly is accomplished and the unit is energized.

Careful examination should be made to ensure that all external electrical connections have been made properly and that the correct ratio exists between low voltage and high voltage windings. To test this, apply a low voltage (240V or 48OV) to the high voltage winding and measure the output at the low voltage winding.

All control circuits, if any, should be checked for operational ability. Furthermore, ,they should be able to withstand a 1200 volt applied insulation test for one minute (if the transformer has current transformer circuits, they should be closed.)

The operation of fans, motors, thermal relays, and other auxiliary devices should be checked. Fan rotation should be visually verified as well as by checking any indicator lights.

As prescribed by NEMA standards, transformers are shipped with both high and low voltage windings connected to their highest rated voltage (except transformers which have taps above the rated voltage, in which case they will be shipped connected for rated voltage.) The internal connections should be checked with the diagram on the nameplate to make sure that the connections are correct for the application. The tap setting should also be verified for the proper voltage.

All windings should be checked for continuity. It is required that a megger test be performed to make certain that no windings are grounded which are not intended to be grounded.

4.0 Testing

4.1 Insulation Resistance - Required

General - The insulation resistance test is of value for future comparative purposes and also for determining the suitability of the transformer for energizing or application of the high potential test.

The Insulation Resistance Test Must Be Successfully Completed For Factory Warranty To Be Valid. Insulation Resistance Test Must Be Conducted Immediately Prior To Energizing The Transformer Or Beginning The Dielectric Test.

Insulation resistance tests should be made before applying the high-potential test. Variable factors affecting the construction and use of dry-type transformers make it difficult, to set limits for this test. Experience indicates that a minimum of 2 megohms (one minute reading at approximately 25 °C) per 1,000 volts of nameplate voltage rating, but in no case less than 2 megohms total, may be a satisfactory value of insulation resistance for the application of the high-potential test.

In insulation resistance is less than the minimum values specified here, do not energize the transformer, proceed to 'drying'.

4.2 Resistance measurements of windings are recommended.

4.3 Polarity

4.4 Power Factor of Insulation

4.5 High Potential Test to 75% of factory test level per ANSI C57.12.91-1979 is recommended provided transformer was not subjected to severe dielectric tests before this.

It is preferable that the dielectric tests (Power Factor and Hi-Pot) be done last.

As in the case of insulation resistance, insulation power factor tests may be of value for comparative purposes in checking the condition of a transformer periodically. Please note that the power factor tests on dry type transformers will be higher than on liquid units because the air is measured as a dielectric.

5.0 Drying

If Megger readings are low it is indicated that the unit needs to be dried.

The measurement of insulation resistance is of value in determining the status of drying. Measurements should be taken before starting the drying process and at two-hour intervals during drying. The initial value, if taken at ordinary temperatures, may be high even though the insulation may not be dry. Because insulation resistance varies inversely with temperature, the transformer temperature should be kept 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 measurement. 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 time as abscissa and resistance as ordinate, should be plotted; and the run should be continued until resistance levels off and remains relatively constant between three and four hours.

CAUTION: Insulation resistance movements should be taken from each winding to ground, with all windings grounded except the one being tested.

Before taking insulation resistance measurements, the winding should be grounded for at least one minute to drain off any static charge.

All readings should be for the same time of application of the test voltage, preferably one minute.

5.1 Methods for Drying

As long as the transformer remains energized, humidity conditions are of no importance. However, if a dry-type transformer is de-energized and allowed to cool to ambient temperature, consideration must be given to the possible effects of humidity.

If the shutdown period occurs during low humidity conditions (less than 30%), no special precautions should be required before energizing the unit. But, experience indicates that if a shutdown exceeding 24 hours occurs during a period of high humidity, particularly if atmospheric conditions are such that they cause condensation to appear within the housing of the transformer, then precautions must be taken. Small strip heaters may be placed in the bottom of the unit shortly after shutdown to maintain the temperature of the transformer a few degrees above that of the outside air. If such a precaution is not taken, the transformer should be inspected for evidence of moisture; and the insulation resistance should be checked. If moisture is present, or if the insulation resistance should be checked. If moisture is present, or if the insulation resistance is low, the transformer should be dried out by one of the methods described.

5.1.1 Drying of Core and Coil Assembly

When it is necessary to dry out a transformer before installation or after an extended shutdown under relatively high humidity conditions, one of the following methods may be used:

A. External heat

B. Internal heat

C. External and Internal heat

Before applying any of these methods, free moisture should be blown or wiped off of the windings to reduce the time of the drying period.

5.1.2 Drying of Core and Coil Assembly

External heat may be applied to the transformer by one of the following methods:

A. By directing heated air into the bottom air inlets of the transformer enclosure.

B. By placing the core and coil assembly in a non-flammable box with openings at the top and bottom through which heated air can be circulated.

C. By placing the core and coil assembly in a suitable ventilated oven.

It is important that most of the heated air passes through the winding ducts and not around the sides.

Good ventilation is essential to prevent condensation from taking place within the transformer or inside the enclosure. A sufficient quantity of air should be used to insure approximately equal inlet and outlet temperatures.

When using either of the first two external heating methods, heat may be obtained by the use Of resistance grids or space heaters. These may be located inside the case or box, or placed outside and the heat blown into the bottom of the case or box. The core and coil assembly should be carefully protected against direct radiation from the heaters.

It is recommended that the air temperature not exceed 110 °C.

5.1.3 Drying by Internal Heat

This method is relatively slow, and should be used only when the other two methods are unavailable.

The transformer should be located to allow free circulation of air through the coils from the bottom to the top of the enclosure. One winding should be short-circuited, and sufficient voltage at normal frequency should be applied to the other winding to circulate approximately 75% of normal current. It is recommended that the winding temperature not be allowed to exceed 100 °C, as measured by resistance, or by thermometers placed in the ducts between the windings. The thermometers used should be the alcohol type or thermocouples.

Proper precautions should be taken to protect the operator from dangerous voltage.

5.1.4 Drying By External And Internal Heat

This is a combination of the two methods previously described, and is, by far, the quickest method. The transformer core and coil assembly should be placed in a nonflammable box, or kept in its own case when suitable, and external heat applied (as described in the first method) as current is circulated through the windings (as described in the second method) . The current required will be considerably less than when no external heating is used, but should be sufficient to produce the desired temperature of the windings. It is recommended that the temperature attained not exceed those stated in the foregoing paragraphs.

6.0 Grounding

The enclosure and core and coil assembly of these transformers should be permanently and adequately grounded.

Grounding is necessary to remove static charges that accumulate. It is also needed as a protection should the transformer windings accidentally come in contact with the core or enclosure. Be sure that the flexible grounding jumper between the core and coil assembly and enclosure is intact, or that the core and coil assembly is directly grounded from the core clamp through a flexible head. Insure that grounding or bonding meets N.E.C. and local codes.

7.0 Connections

Make only those connections specified by the nameplate or connection diagram, check all tap jumpers for proper location and tightness, and re-tighten all cable retaining bolts after the first 30 days of service.

This transformer has been designed and built to provide excellent electrical connections using either copper or aluminum connecting cable, copper cables are preferred. A protective plating or compound which prevents surface oxidation of the aluminum terminals was applied at the factory. This coating should be removed from tap or line terminals. If in the case of protective compounds it becomes necessary to reapply it, clean all contact surfaces of oxide and re-coat with a good quality compound, following the manufacturer's instructions. Many kinds are commercially available. Some of them are Penetrox A, Alnox-UG, and Thomas & Betts 21059. When re-coating, wipe off any excessive compound.

It is advised that when aluminum conductors are used, they be given a protective compound treatment as specified by the cable manufacturer. Furthermore, all bolted connections involving aluminum conductors should be re-torqued after 30 days' service.

Depending upon KVA rating, this transformer may have Cu/Al lug connections or termination pads for mounting of your own crimp type or lug type terminations or bus termination connections.

Torque Inch Pounds

Bolt Size	Copper Bus	Aluminum Bus
1/4 - 20	75	65
5/16 - 18	170	60
3/8 - 16	305	280
1/2 - 13	740	675

NOTE: Tighten, wait several seconds, then re-tighten all connecting lugs and bolts.

Where cable terminations are supplied by the user, it is recommended that commercially available, properly sized, UL listed screw type or crimp type connections be used. These terminations should be attached to the cables as specified by the termination or cable manufacturer. Terminations are readily available from wholesale electrical distributors. Do not install washers between the terminal lugs and the termination bus bar as this will cause heating and arcing in that area, resulting in connection failure.

The termination area of this transformer has been designed for easy accommodation of cable sizes in accordance with the National Electrical Code. Cable sizes should be based on ampacity at 125% of nameplate rating. 20 °C rating through 100 amperes, 105 °C rating above 100 amperes. Customer installed cables must be kept as far away from coils and top blades as possible. If in doubt about clearances, call factory.

Minimum electrical clearances in the installation of lugs and cables must be per NEC 373-11. All electrical clearances that are questionable must be insulated with electric tape.

8.0 Operation

8.1 Placing in Service

Before energizing the transformer, arrange to monitor the voltages on the LV side. Then without connecting the load, energize the transformer, the voltages should be symmetrical. If in doubt, de-energize the transformer and contact factory before proceeding further.

After following the preceding instructions, the transformer may be energized. It is recommended that the unit first be energized at no load followed by a stepped or gradual application of load until full loading is reached. If it is not possible to graduate the load, then full load may be applied.

NOTE: Upon initial energizing and bringing up to full load, some temporary vapor or smoke may be given off from the unit coils/core assembly - this is not an uncommon occurrence, and is due to heating of residual varnish in the coils. This condition will disappear in a few hours after stabilizing at normal operating temperature.

8.2 Parallel operation

When operating transformers in parallel, their rated voltages, impedances, and turn ratios ideally should be the same. Their phasor relationships must be identical. if these parameters are different, circulation current will exist in the circuit loop between these units. The difference in impedance should in no case exceed 10%. The greater the differences in these parameters the larger-r the magnitude of the circulating current. When specifying a transformer to be operated ii parallel with existing units, all of these parameters should be noted.

8.3 Loading

Before connecting the load, de-energize the transformer and arrange to monitor voltages and currents on LV side. Connect the load and energize the transformer. Then while monitoring the voltages and currents, increase the load. The voltages and currents should change symmetrically. If in doubt, de-energize the transformer and contact factory.

The maximum continuous load a transformer can handle is indicated on the nameplate. However, many specially designed units have specific load capabilities designed into them. If there is any question concerning the load capability of the unit, the factory should be consulted. Refer to ANSI Standard C57.96 Guide for Loading Dry-Type Distribution and Power Transformers for general guidelines.

Minimum electrical clearances in the installation of lugs and cables must be per NEC 373-11. All electrical clearances that are questionable must be adequately insulated with electrical tape. Grounding of the enclosure as per NEC 450-10, Article 250 is required. Check the grounding of the neutral as

applicable per National Electrical Code. Remove the neutral to ground or connect neutral to ground as required.

Overload protection for primary and secondary circuits is covered by the National Electric Code, Article 450.

8.4 Shipping Supports

After the transformer has been placed in its permanent location, the hold-down bolts securing the core and coil assembly to the base or enclosure must be loosened but left in the holes to act as horizontal restraints. This loosening releases the sound isolation pads for maximum effectiveness. Also remove any shipping braces on the core and coil busses or the enclosure. For easy identifications, these braces will usually be painted a different color from the remaining assembly parts, or made of wood, or left unpainted.

Should it ever be necessary to move the transformer, replace the hold-down bolts and braces for the moving operation.

8.5 Tap Changing

After installation, the output voltage of the transformer should be checked at some safe access point on the load. Never attempt to check the output voltage at the transformer since dangerous high voltage may be present within the transformer enclosure.

When the output or load side voltage requires adjustment either up or down, the percentage tap jumpers found on the front surface of the coils must be changed in all phases. Consult the transformer diagrammatic nameplate for information on what tap must be used to correct for high or low incoming line voltage or for voltage drop in the output or load voltage due to long wiring runs. Note that when the load voltage is low, tap connections below 100% of line voltage must be used to raise the load voltage. If the load voltage is high, tap connections above 100% of line voltage must be used to lower the load voltage.

After the correct tap connection has been determined from the nameplate, this procedure should be followed to change taps.

1. De-energize transformer. Make sure there is no back feed from a low voltage tie breaker.

2. Remove front access panels from transformer enclosure

3. Change tap jumper on each phase to the correct tap connection. Tap jumper must be on the same tap position on all phases.

4. Tap jumper must, be installed on upper side of coil tap with lugs on ends of cable tap jumpers positioned for maximum electrical clearances from ground and other live parts. Be sure bolts are tightened.

5. Replace front access panels.

6. Energize transformer and recheck the output voltage.

9.0 Maintenance

WARNING: De-energize transformer before any inspection or maintenance!!

9.1 Periodic Inspection

Like other electric equipment, all transformers require maintenance from time to time to assure successful operation. Inspection should be made at regular intervals and corrective measures taken when necessary to assure the most satisfactory service from this equipment.

Operating conditions determine the frequency at which these transformer should be inspected. For clean, dry locations, an annual inspection may be sufficient. However, for other locations, such as may be encountered where the air is contaminated with dust or chemical fumes, more frequent inspections may be required. Usually after the first few inspection periods, a definite schedule can be established.

With the transformer de-energized, enclosure panels should be removed. Inspection should be made for dirt, especially accumulations on insulating surfaces or where such accumulations could restrict air flow. Inspection should also be made for loose connections, for the condition of tap changers or terminal boards, and for the general condition of the transformer.

Observation should be made for signs of overheating and of voltage creepage over insulating surfaces as evidenced by tracking or carbonization.

Evidence of rusting, corrosion and deterioration of the paint should be looked for and corrective measures should be taken, where necessary. Furthermore, fans, motors, and other auxiliary devices should be inspected and serviced during inspection periods.

9.2 Jackscrew (Coil Clamping) Assembly Adjustments

Check each jackscrew assembly for proper torque by attempting to move the coil block with the hand from side to side. If motion exists, tighten the jackscrew assembly following the outline procedure. (Caution should be observed when handling nuts, bolts and washers to prevent dropping them into the coils.)

A. Tighten lower jacking nut while holding jacking bolt until coil block can no longer be moved by hand.

B. Tighten lower jacking nut an additional 1/2 turn.

C. Apply air dry varnish to nut and bolt assembly.

D. Repeat as required on other jackscrew assemblies.

9.3 Cleaning

If excessive accumulations of dirt are found on the transformer windings or insulators when the transformer is inspected, the dirt should be removed to permit free circulation of air and to guard against the possibility of insulation breakdowns. Particular attention should be given to cleaning the top and bottom ends of the winding assemblies and to cleaning out the ventilating ducts.

The windings may be cleaned with a vacuum cleaner, a blower, or with compressed air. The use of a vacuum cleaner is preferred as the first step in cleaning, followed by the use of a compressed air or nitrogen. The compressed air or nitrogen should be clean, oil free, and dry and should be applied at a relatively low pressure (not over 25 pounds per square inch). Lead supports, tap changers and terminal boards, bushings and other major insulation surfaces should be brushed or wiped with a dry cloth. The use of liquid cleaners is discouraged as some of them have a solvent or deteriorating effect on insulating materials.

In case of OUTDOOR UNITS, remove any snow/other accumulation in front of the ventilation openings to allow free entry of cooling air. Check inside the enclosure for signs of any gasket leaks. Replace as required.

10.0 Storage

Ventilated dry-type transformers preferably should be stored in a warm dry location with uniform temperature. Ventilating openings should be covered to keep out dust. if it is necessary to leave a transformer outdoors it should be thoroughly protected to prevent moisture and foreign material from entering. Condensation and the absorption of moisture can be prevented or greatly reduced by the immediate installation of space heaters or small electric heaters. For transformer ratings 750 KVA three phase and below, use 6 - 150 watt lamps, above 750 KVA three phase, use 6 - 300 watt lamps or equivalent. Two lamps should be located under each coil, one on each side of the core. Lamps or heaters should be kept 4-6 inches from transformer coils and should never be allowed to come in contact with transformer coil insulation.

11.0 Removal From Service

If a unit is to be off more than 24 hours, provisions should be made to prevent the core and coils from taking on moisture. Refer to "Storage".

If the unit is to be moved, it will be necessary to replace the core and coil hold-down bolts and any shipping braces used for first shipment to protect the assembly during movement.

12.0 Renewal Parts

Should a transformer be damaged and new parts needed, write to supplier giving full nameplate information. Be sure to include the serial number of the transformer and a description of the part desired. If the proper name of the part is in doubt, a simple sketch or photograph will expedite prompt shipment to you.