DELTA
TRANSFORMERS
TRANSFORMATEURS

INSTRUCTIONS

FOR

INSTALLATION,

OPERATION

&

MAINTENANCE

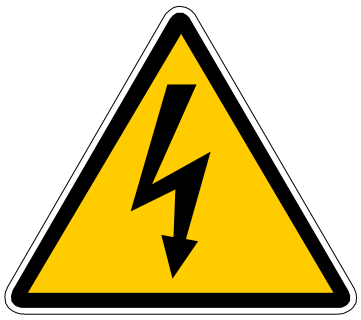
FOR

INDOOR/OUTDOOR

VENTILATED

DRY TYPE

TRANSFORMERS



WARNING

- ✓ Carefully read the instruction manual and get familiar with the equipment you have just received before installation, energizing or maintenance.
- ✓ Ensure equipment is de-energized prior to any work.
- ✓ Do not rely on any visual indication like a switch position and take for granted that the transformer is de-energized. Use appropriate voltmeter.
- ✓ Only insulated tools designed to protect against electrical shock should be used.
- ✓ Recommended personal protective equipment should be used for any work near this equipment.
- ✓ Before any maintenance, ensure static loads have been drained through winding ground using appropriate equipment.
- ✓ Reinstall equipment, panels, covers and/or doors before re-energizing equipment.
- ✓ Non-compliance with these instructions may cause severe injury or death!

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1. CHOICE OF POWER RATING

1.1. The Power Rating of a transformer should be chosen in consideration of the following:

- ✓ The Load Current and the possibility that circuit overload may occur;
- ✓ The presence of repeated transient currents in the circuit, such as the initial magnetization current due to other transformers, the starting current of a motor and the starting voltage currents of capacitors;
- ✓ The compatibility of the other components and protection systems in the circuit;
- ✓ The life span and required maintenance of the auxiliary equipment such as fans and controls;
- ✓ The heat class of the transformer (operating temperature).

2. INSPECTION, HANDLING AND STORAGE

All transformers manufactured by DELTA are carefully assembled, tested according to CSA standards and inspected before leaving the plant. All transformers are individually wrapped and adequately mounted to protect them against possible damage during handling, shipping and storage.

2.1. Inspection

Each transformer should be inspected upon receptoion in order to check if any damage has occurred during transport. In a case damage is obvious or visible signs of abuse during handling occurred, claim procedures must be taken against the transport company. An internal examination of the transformer may be done by removing the top or front access panel. This inspection will assess if parts have shifted, broken connections or insulation, and reveal the presence of dirt, water or mildew. We recommend this inspection procedure be completed and to check the torque value of the bolts before putting the transformer in service. Torque values are indicated on pages 5 & 6 as well as in section 3.3 of this manual.

2.2. Handling

2.2.1. The handling of transformer requires good judgment on behalf of the operator. Suitable equipment must be used, lift-truck or crane, which has proper capacity to safely lift and manipulate the weight of the transformer.

2.2.2. Lifting eyes have been fitted to the frame and/or the enclosure of the transformer to ease the use of a crane. 150 kVA transformers or less have the lifting eyes mounted to the enclosure, while units greater than 150 KVA, are mounted to the frame. In the latter case, it is necessary to pull back the packaging on top of the transformer and remove the cover to access the lifting eyes on the frame. Once completed, it would be preferable to replace the cove to prevent infiltration of water and dust.

2.2.3. After handling the transformer, we recommend that all bolts and nuts be torqued as per drawings below. For a transformer having 3 mounting feet, refer to figure 1. For a transformer having 4 mounting feet, refer to figure 2. It is common for bolting hardware to become loose during transportation.

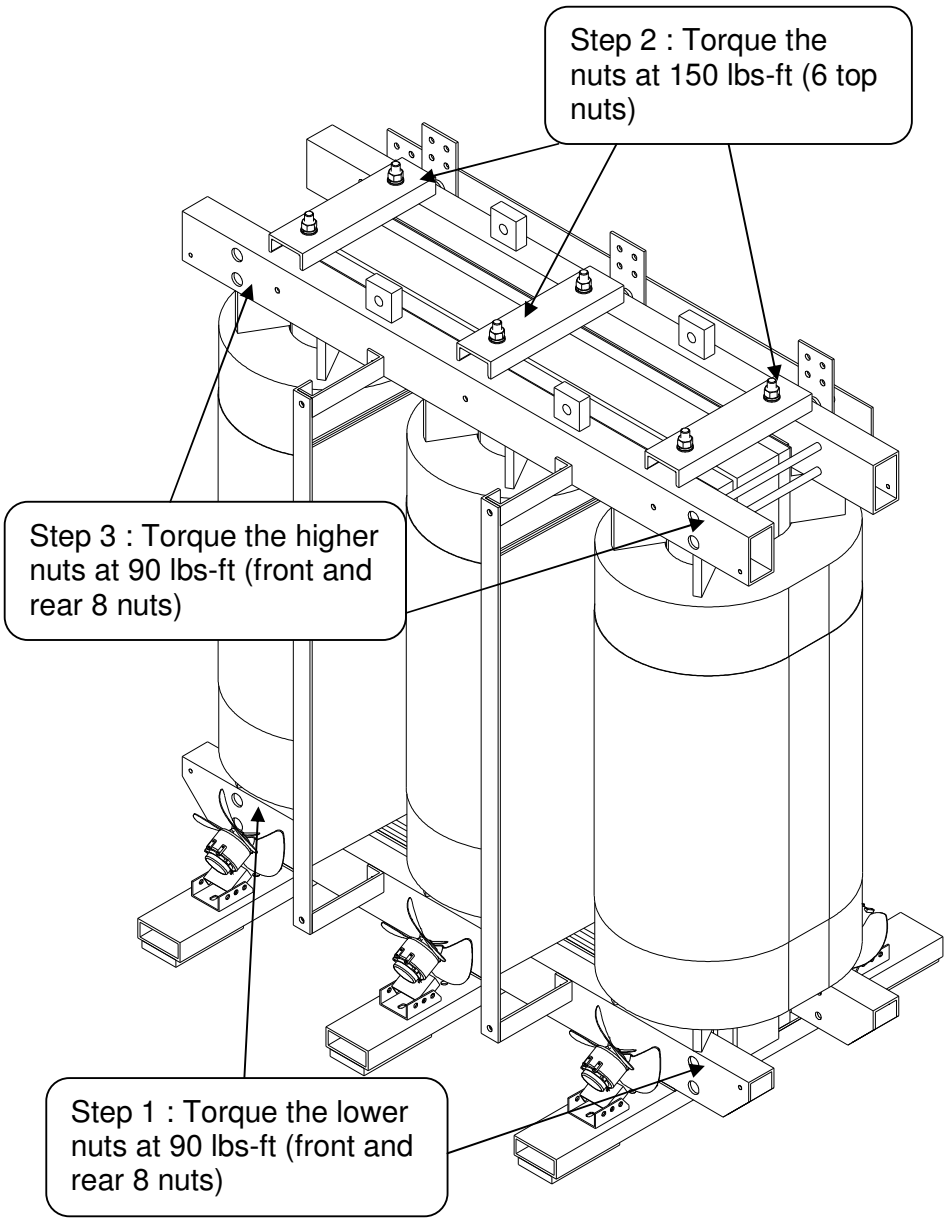

Figure 1

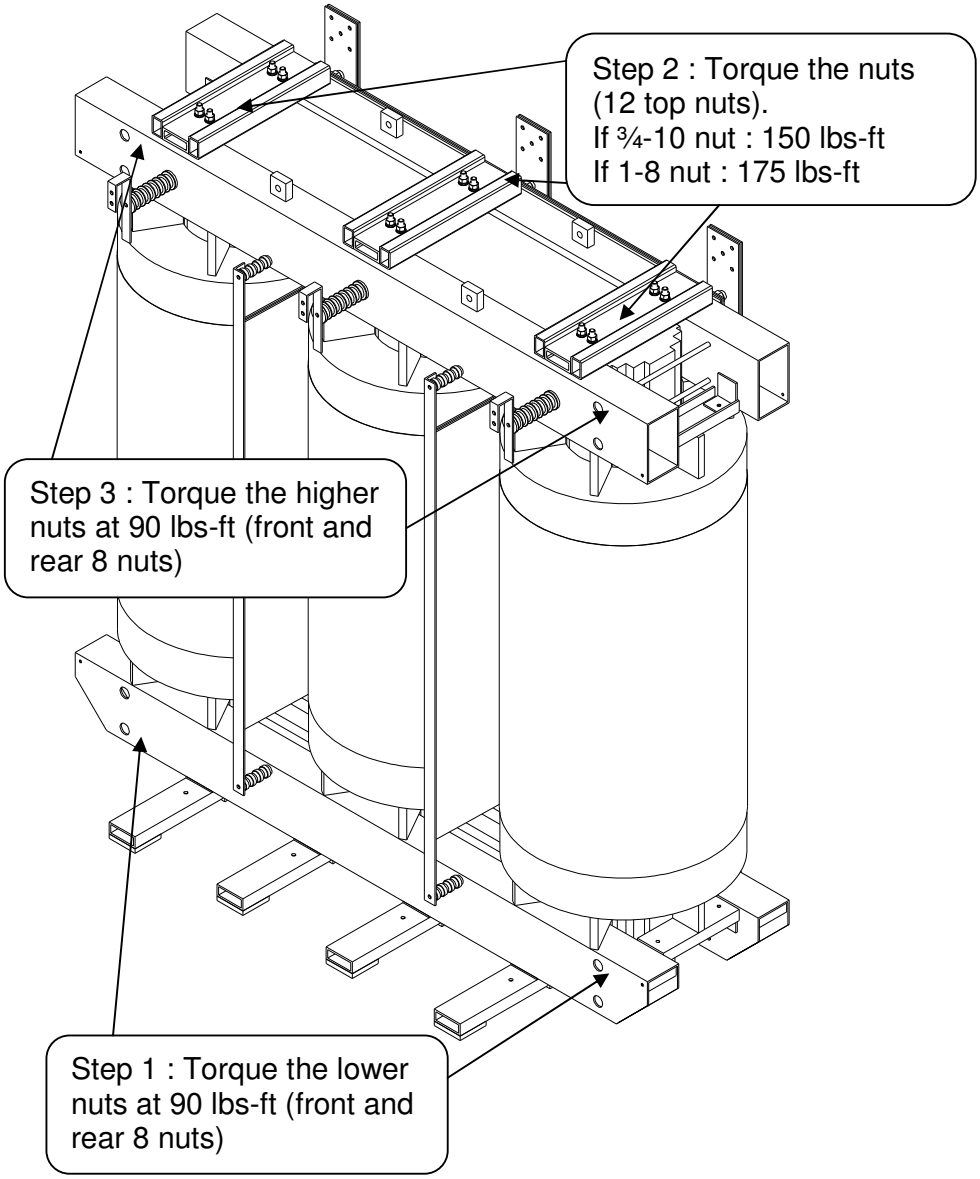

Figure 2

2.3. Storage

All transformers should be stored indoors, in a clean and dry location. Ventilation openings should be covered to prevent the infiltration of dirt or dust. If a transformer is stored outside, it must be carefully sheltered against dampness and the outdoor weather elements.

3. DRY TYPE TRANSFORMER INSTALLATION

The proper operation of the dry type transformer essentially depends on the site, the load applied, and the maintenance being done. Neglecting any one of these criteria's could bring about certain degradation and eventually the lost of the transformer.

3.1. Site (Location)

3.1.1. Humidity

This type of transformer is usually designed for an indoor installation and in a relatively dry location. In an environment with a high a level of humidity does not necessarily impede on the normal operating capabilities, but in such a case, certain precautions must be taken in order to insure that the dampness does not affect the physical properties of the transformer. When the transformer is not in operation for a period of more than 24 hours, during which the level of humidity is relatively high and that the atmospheric conditions cause condensation on the enclosure, an external heat source must be placed close to the transformer in order to protect the electrical insulation properties.

3.1.2. Ventilation

Adequate ventilation is necessary to maintain the transformer at an appreciable temperature. Consequently if installation is made in a restricted space, sufficient ventilation must be supplied to maintain an adequate temperature. The necessary surface for the ventilation openings depend on the power rating (KVA) of the transformer, the losses in the form of heat in KW, the difference in height between intake and exhaust and the difference between air temperature at intake and exhaust. This ventilation is designed to enable an adequate ventilation of the transformer and should never be submitted to any obstructions. We must therefore insure that no surrounding objects can create interference with the ventilation surface. When a transformer is installed in a limited space, it is essential to maintain an adequate ambient temperature.

To achieve this compensate the temperature rise by adding fans, increasing the air circulation, or derate the nominal power in KVA in order to lower heat dissipation.

3.1.3. Environment

A clean environment will contribute to the proper operation of the transformer. Consequently, if installed in an area where the ambient air contains dust, corrosive vapors or metallic particles, it is recommended to use a filter since certain substances could be damageable to the transformer. It is also possible to use an enclosure of the totally enclosed type (CSA Type 4) or a resin encapsulated transformer which enables the core and coils to be isolated from the ambient surroundings.

The use of filters: only those specified by the manufacturer should be used, since inadequate filters may prevent a proper ventilation of the transformer hence causing overheating. Furthermore, filters should be periodically examined in order to insure an adequate ventilation of the transformer.

Areas where water dripping occurs must be avoided. Furthermore, precautions must be taken to prevent the accidental presence of water that may originate from an open window during bad weather, a ruptured pipe or the misuse of water near the transformer. The use of an enclosure of the waterproof type (CSA Type 3R) would be justified for an environment where the presence of water is inevitable.

3.1.4. Spacing

Floor mounted transformers and nearness to a wall or other structures must abide to a minimum distance between the enclosure and each of the walls. This distance is usually indicated on the transformer enclosure. For maintenance purposes, a good accessibility must be taken into consideration during the choice of the installation location. If the transformer is to be located near combustible materials, a minimum distance established in the Canadian Electrical Code must be abided by.

3.1.5. Noise

Audible Noise arising from the transformer may be an important factor in the choice of location. Note that the noise may be cause by two factors: The noise produced by the transformer itself and or equally by the noise caused in the transmission of the vibration through the foundations and the connections. It is therefore necessary to make a few modifications for the installation in areas where a high level of noise is undesirable. Typical options are mentioned below:

- ✓ Use of flexible connectors to make the bus bar links.
- ✓ Cover walls and ceiling with sound-proofing materials.
- ✓ Use Anti-Vibration Pads and set-up the transformer on a secure base. For example: do not install on a wooden floor. It is even advised that in critical cases the installation of the transformer be made on a floating slab in a way to limit the transmission of vibrations.
- ✓ Structural nuts and bolts on the core and coils can come loose. See point 2.2.3 above for instruction.

3.2. Load

Certain precautions must be taken when a load is to be applied to the transformer. Firstly, we must be insured that the current circulating in the windings does not exceed the value of the acceptable nominal current for each of the windings. Furthermore, the loads must be balanced. In the case where the transformer is used for diode rectification or other applications which generates a distortion in the current wave, it is recommended to use a "true RMS" type ammeter in order to read the exact values of the current.

3.3. Maintenance

Not unlike other electrical equipment, the transformer requires periodical inspection and maintenance. These preventive measures must be taken at regular intervals and corrective measures must be taken when they become necessary, they must be carried out as soon as possible.

The ambient conditions in which the transformer operates will determine the frequency of inspections. A transformer may function very well for several years without particular attention, but submitted to unfavourable conditions (area where air contains salt, dust, corrosive vapours, metallic particles or other harmful matters) would require a monthly inspection.

Care must be taken when inspecting a transformer that is in operation. This care includes such things as a peripheral inspection, an external clean-up and an external paint touch-ups.

Care must also be taken when a transformer is not in operation. This includes but is not limited to "tap-changing", an internal inspection and clean-up, to locate the cause of mediocre performance, the replacement of defective parts, an internal paint touch-ups. These corrective measures must be carried out by a trained competent person familiar with the operation of the transformer.

Before initiating any maintenance:

- ✓ Make sure that the transformer is SHUT-OFF (de-energized).
- ✓ The up-stream main breaker or switch must be padlocked in the open position.
- ✓ After the shut-down short-circuit the primary and secondary terminals and ground them.
- ✓ Check the connectors for proper positioning, tightening, oxidation and corrosion, and replace oxidized connectors. In certain cases, if oxidation is superficial, you may restore the conductive quality of the contact surface with a fine sand-paper.
- ✓ Verify the torque of the bolts, nuts and washers.

TORQUE VALUES FOR BOLTS.

Bolt size	Copper bar	Aluminum bar
3/8 - 16	30 lb./ft.	30 lb./ft.
1/2 - 13	60 lb./ft.	60 lb./ft.

- ✓ Check all insulated links in order to detect any signs of overheating. If overheating occurs, the link must be remade and re-insulated.
- ✓ Remove all excessive accumulation of dirt on the windings or on the insulation of the transformer to enable a free circulation of air and protection against insulation break down. A layer of dirt on the

windings will act as a blanket which may cause the overheating of the transformer. Operating at a higher temperature rise will have a direct impact on the life cycle of the insulation. For this reason, particular care must be taken to clean the top and bottom of the coil assembly and to clean the ventilation ducts. The windings may be cleaned with a vacuum, a fan or with the use of compressed air. The vacuum is more advisable for the first cleaning step, afterwards if necessary, the use of a fan or dry compressed air or dry nitrogen will finish off the work. The clean-up procedure must be made while taking care that the blast of air used, not exceed 25 pounds per square inch. The use of a high pressure blast must be avoided since it may insert metallic particles in the insulation. The terminal boards, the frames, the tap changers and the insulators should be wiped clean with a dry cloth. The use of liquid cleaners or solvents is not recommended since several of these have a destructive effect on insulation.

4. COLD START

All dry type distribution and power transformers manufactured are required to be capable of being started up at -30c per CSA C22.2 No 47 and IEEE C57.12.01. Dry type transformers are manufactured using various methods such as Paper and Varnish, VPI (Vacuum Polyester Impregnation) and EVI (Epoxy Vacuum Impregnation).

One of the limitations of designing to a low temperature start up is the potential effect of moisture present on startup, Delta's process in manufacturing our transformers consists of a Vacuum Pressure Impregnation Process with periods under vacuum, followed by pressure impregnation using epoxy resin as part of a class 220 UL-1446 Listed Insulation System (EVI process). This Optimized Epoxy Impregnation Process allows for sealing of the core, windings and conductor leads. It provides Hydrolytic stability under electrical stress, environmental contamination or abrupt temperature variation.

The manufacturer of the Epoxy we use in this process has confirmed the temperature range is down to -45c. This is why it is capable of being out in most outdoors areas with blowing snow and features a Chemical resistance to H2S , H2S + Salt and has a US mil-spec qualified Fungus resistance. However, temporary heat should be applied to unit until it reaches an average of -30 degree Celsius and that no sign of frost is visible. Then power could be supplied to transformer. After half an hour of operation under no load condition, loads can be added gradually to unit.

5. DRYING

When a dry type transformer is stored in a humid area for a certain period of time, it is recommended to proceed by drying the unit before making use of it. The drying may be done by an external source of heat (by blowing warm air through the ventilation ducts) or by an internal source of heat (by short- circuiting one of

the windings and having the circulation of a current at low voltage) or by the combination of both methods.

Drying time will depend on the condition of the transformer, of its size, of the humidity it absorbed and the drying method used. The state of the insulation may be assessed by taking a measure of the resistance with the help of a megohmmeter. To determine when the drying operation can be considered complete, at the time of commencing the procedure, and at regular 2 hour intervals during the drying process. The process will be ended when the resistance values will cease to increase after a few readings. Each method is described in details below.

5.1. External Heat

Firstly any signs of mildew on the transformer must be wiped clean. Secondly, external heat should be applied using one of the following methods:

- ✓ By blowing warm air through the intake of the transformer enclosure.
- ✓ By placing the core and coil assembly in an appropriately ventilated oven, to eliminate the humidity.

It is very important that the warm air pass through the ventilation ducts of the coils (windings) and not just around the lining. Proper ventilation must be such that no condensation forms on the windings or on the inside of the enclosure. A suitable quantity of air should be maintained to insure an equivalent flow at the intake and at the exhaust.

Care must be taken to protect the core and coil assembly against direct radiation originating from the heat source. Furthermore, it must be insured that the circulation of air inside the transformer not exceed 100°C.

5.2. Internal Heat

This method is relatively slow, and is less preferable than the external heat method. Firstly, signs of mildew on the transformer must be wiped clean. One winding (secondary) should be short-circuited, and sufficient voltage at normal frequency applied to the other winding (primary) to circulate approximate rated current.

The percent impedance stamped on the nameplate will give a guide as to the voltage required. For example, a transformer with 3.0 % impedance will require 18 volts on a 600 volts winding, or 72 volts on a 2400 volts winding to circulate rated current (required voltage = impedance % (IZ) X rated voltage). The current heat dissipation must not bring the winding to an excessive temperature rise.

5.3. External and Internal Heat

This method is a combination of the two previous ones and is probably the fastest of the drying methods. The transformer is placed in a fire-proof cabinet or within its own enclosure. External heat is applied following procedure described in part

4.1 and an external heat is generated by procedure described in part 4.2. Yet, this method will require a less important short-circuit current (lower applied voltage), since the surrounding temperature will be higher.

When applying this method we must insure not to cause an excessive temperature rise in the windings.

6. TAP CHANGING PROCEDURE

Before changing taps, make sure to follow the procedure below to avoid electric shock or transformer damage.

- ✓ Make sure that the transformer is de-energized (shut-off).
- ✓ The up- stream and down-stream main circuit breaker or switch must be padlocked in the open position.
- ✓ After the shut-down, short-circuit the primary and secondary terminals and ground them.
- ✓ Proceed tap changing by moving the tap link on the desired tap following the ¨ADJUSTMENT TAPS¨ plate on the transformer enclosure.