LIQUID FILLED TRANSFORMERS RECEIVING, INSTALLATION, MAINTENANCE AND OPERATING INFORMATION

INTRODUCTION- The information provided in this manual on shipping, handling, inspection, storage, proper operation and maintenance of oil filled transformers, is provided as a guide. This is a brief outline for the proper procedures and requirements for the general and required care that must be followed. This is in addition to the standard ANSI and NEC requirements for the design of and location for your equipment. Neglect of these fundamental requirements may lead to serious trouble, if not the loss of the transformer or other vital equipment. This book is not a substitute for the proper training or safety related working procedures for high voltage connection or repair.

PART-1 SHIPPING, RECEIVING, HANDLING AND STORAGE

1.0 Shipping- Three phase oil filled transformers are normally shipped completely assembled and ready to to install. Three phase transformers rated 500 KVA or smaller are shipped on a pallet, being securely attached to the pallet by means of metal straps banded through the lifting lugs. Three phase transformers rated 750 KVA and above are shipped on flat bed or open top truck due to the size and configuration of the transformer.

1.1 Receiving and Inspection- The transformer has been carefully assembled, filled with insulating fluid, tested and sealed at the factory. The transformers should be carefully visually inspected upon receipt prior to unloading. The inspection should include checks for any external damage, proof of rough handling or missing components. The following basic checks should be followed:

1-The packing list should be inspected to verify all boxes containing misc. parts are complete and there.

2-Check for obvious dents and scratches especially on the radiators and the tank assembly. Then inspect the cabinet front doors, sills, top covers.

3-Inspect for any coolant leaks. These may show up as oily streaks or dark stains on the side of the transformer or surface of the shipping pallet or truck bed. If a leak is detected, this should be evaluated whether it is a pin- hole leak or bushing leak that can be field repaired. If the leak is a flowing leak found to be damage from rough handling, **contact the factory and the trucking company immediately!**

CAUTION: *IF THERE ARE ANY SIGNS OF OIL LEAKS OR ACCESS TO THE INTERNAL COMPONENTS OF THE TRANSFORMER ARE REQUIRED, PLEASE CONSULT THE FACTORY. IF ANY REPAIRS ARE MADE BY ANY UNAUTHORIZED TECHNICIANS THIS CAN VOID YOUR WARRANTY.*

4-Check the nameplate for the proper ratings and data pertinent to the transformer ordered are correct. See figure **(2)** for the information and its location.

After these basic inspections, the transformer can be unloaded at your site.

1.2 Handling-Lift the transformer utilizing all the lugs and proper spreaders to obtain a vertical lift with proper weight distribution and without damaging the

CAUTION: *DO NOT LIFT THE TRANSFORMER BY USING CRANES OR JACKS ON ANY PART OF THE UNIT OTHER THAN THE LIFTING LUGS OR THE JACKING AREAS PROVIDED FOR THIS PURPOSE. IMPROPER LIFTING OR JACKING MAY RESULT IN SERIOUS PERSONAL INJURY AND DAMAGE TO PROPERTY.*

1.2 Lifting- The lugs supplied on the transformer were meant for vertical lift only and not for pulling the transformer in a horizontal direction. There must be a balanced force on all four lifting lugs for a proper lift. Proper spreader bars will be required if loops do not straddle the corners of the unit. This will help prevent strain on the tank wall and lifting lugs.

1.3 Jacking-May be accomplished by using the proper jacking areas or the corners of the base of the tank area. See caution below.

When the transformer can not be moved by the use of a crane for placement, it can be skidded or moved on rollers into position. Care must be taken not to damage the base of the tank. The rollers **can not** be placed under the cabinet structure as this is not a structure supported area.

1.4 External Inspection The next step in the inspection would be to open the cabinet doors and view the components located in the high and low voltage terminal chambers. The high voltage will be located on the left hand side of the full length barrier and the low voltage on the right hand side.

It is important to locate the nameplate and verify all pertinent data is correct. See figure **(1)** for the locations of the required nameplate information as follows: KVA, Primary voltage, Secondary voltage, Tap locations and voltage, Percent of impedance, Phase, Frequency, Temperature rise, connection diagram, weight and vector diagram.

Tighten any parts that may have worked loose during shipment. Components such as bushing flange bolts should be adjusted with extreme care as not to over-tighten and loose the integrity of the gasket or crack the porcelain insulator. Check all accessories to verify no damage is present such as cracks or chips in the bushing assembly, cracks in the site glasses of the gauges, bent or out of place components.

Torque settings:
The bushings and the flange bolts should be inspected and if required, adjust to the following settings:

Bushings clamps for porcelain bushings: 60 inch-lbs.
Clamps for Epoxy style bushings: 100 inch-lbs.

Hand hole cover or other bolted openings in the tank: 175 inch-lbs.

Check the outline drawing for the specific accessories present for your transformer. The location of most accessories will be in the high and low voltage compartment unless of a special application. See figure **(2)** for a basic location of most accessories on a standard pad mount.

The oil or fluid level of the transformer can be checked via the liquid level gauge or removing the fluid level plug. The plug is located at the 25 Degree C level of the transformer. Follow the procedure below for the proper way to vent the transformer before checking the fluid plug. Any unit not containing the proper fluid level should be rechecked for leaks.

1.5 Internal Inspection- Internal inspection is **not** required for this unit, however if the transformer must be opened for inspection or fuse replacement, take proper care to prevent the entrance of moisture or other foreign matter into the transformer. The entrance of moisture into the sealed interior of the transformer can destroy the insulation level of the oil causing break down in the dielectric strength which can result in failure of the unit.

AS ALWAYS WITH ANY INTERNAL INSPECTION WHILE THE TRANSFORMER IS UNDER WARRANTY, CONSULT THE FACTORY BEFORE ACCESSING THE INTERNAL COMPONENTS OF THE UNIT.

1.6 Seal Integrity For an inspection, the following recommendations should be followed:

1-Occasional checks of the pressure vacuum gauge should be made (if your unit is equipped with one) and verify the unit has a proper seal. This would be verified by the rise and fall of the pressure with the increase or decrease in the temperature of the cooling liquid and the ambient temperatures. If there are no changes in the reading of a constant zero pressure the unit must be checked for leaks and repaired to prevent moisture from possibly contaminating the oil.

To further verify for leaks. The gas space in the transformer can be pressurized to 5 PSI with dry nitrogen. The pressure should be monitored for a period of 24 hours. Although a decrease in the pressure does not constitute a leak. A change in the ambient temperature either increase or decrease will result in in a pressure fluctuation. If there is a significant drop in the pressure. Pressurize the unit again to 5 PSI. Mix a solution of liquid soap and water and begin brushing around the bushing gaskets where the seat against the tank, around gauges where they fit the flanges and around all gasketed hand hole covers. Then proceed to check the welds above the oil level. Below the oil level a chalk dust can be used to verify any liquid leaks which may be coming from the tank. **Be sure to remove all soap solution from the tank either by rinsing or a clean wet rag before removing the pressure from the tank.**

2-Make sure the transformer is properly vented first before the unit is opened. Locate the pressure relief valve pull ring and pull forward to relieve pressure gradually. If the unit is not equipped with a pressure relief valve, locate the vent plug to relieve the pressure. If there is no sign of pressure there is still may be an effective seal on the unit. The unit may have been sealed at the factory during a time when the ambient temperature and the pressure are the same as when the unit was sealed at the factory. If this is found, wait until another time in the day or week when the temperature or loading conditions may have changed. If it is still found to be unchanged follow the procedure in the minor repairs section. **For additional information consult the Minor repairs section only.**

1.7 Storage-If the transformer is not to be put into service immediately, it is advisable to place the unit, complete with oil in its permanent location. If this is not possible, it should be placed in a dry location which is not subject to wide temperature variations. Oil filled transformers should not be stored for an extended period of time, if they are, basic electrical tests should be conducted by qualified technicians. These tests should be a megger readings and TTR . The tests should be verified with the original results from the factory to assure they are still within acceptable limits.

1.8 Location-The choice of location must be given special consideration. This is due to oil filled units relying on the surrounding air to cool the transformer and vent away heat. For units mounted indoors, this is especially critical. In enclosed areas, the fresh incoming air vents should be located as close to the floor as possible. There should be a minimum of 30 inches of clearance from walls and separate transformers. Exhaust air vents should be mounted close to the top of the ceiling where the air is warmest. The mounting surface should be a level location with sufficient strength to support the weight of the transformer. There should be no more than 2 degrees tilt on the unit. This is especially critical to maintain proper oil levels over the accessories and the core and coil assembly. The pad should be so designed as not to allow water to puddle on the location. It is also important for the maintenance of the security integrity for the unit to remain flush against the mounting surface at all times.

PART-2 CONNECTIONS, ENERGIZING CAUTIONS, CHECKS AND LOADING

2.1 Connections-It is recommended that the following sequence of events be followed:

1-Verify there is no voltage on the incoming cables.

2-Install and connect all ground points and verify that it is a solid low resistance ground. The ground connections are located on the tank front wall near the bottom in both the high and low voltage compartment. These are either a ground pad or ground nuts. Do not use the cubicle hold down tabs or any other plug fitting to establish a tank ground.

3-Connect all low voltage cables in conjunction with the proper connectors or lugs securely bolted to the NEMA spade terminal. Lugs are normally not supplied with the transformer. Air clearances should be maintained per the latest ANSI standards. Clearance of a minimum 1 inch should be maintained between phase to phase and phase to ground, to live parts on 600 volt connections.

4-Connect all high voltage cable in conjunction with the proper shielded cable and stress relief terminator where required. Air clearances should be maintained per the latest ANSI standards.

4.a-Live front design connections are made with proper shielded cable and stress relief terminators. The connection shall be a eye bolt design or a spade connector with a NEMA pattern design hole pattern. Insure that the proper air clearances between all live parts and ground are within the ANSI standard C57.12.22. If it is required to remove the phase barriers during the connection process be sure these are reinstalled before proceeding.

4.b-Dead front design connections are made thru the use of bushing wells , inserts and elbow connectors. Elbow connectors must be sized per the incoming Cable dimensions. The inserts and elbows are not part of the transformer package and must be purchased as separate accessories. The manufacturers of connectors are Cooper® Power Systems and Elastimold®.

5-Units designed for use on a grounded wye system must have the neutral solidly grounded to

the neutral of the system prior to energizing.

2.2 Energizing Cautions-These basic checks should be made before proceeding to place the transformer on line:

CAUTION: FAILURE TO FOLLOW THE RECOMMENDATIONS BELOW CAN RESULT IN DANGER TO LIFE AND DAMAGE TO PROPERTY.

1 -The transformer must be **de-energized** before changing voltage settings by either the tap changer or the dual voltage switch.

2-Three-phase transformers are only designed for proper operation with all three-phases energized: Operating with one or more phases open can result in unbalanced service voltages and single-phasing of the load.

3-Three-phase transformers may exhibit abnormal voltages and current behavior when switched one phase at a time. Three-phase switching is recommended whenever available or possible, particularly when conditions susceptible to ferro resonance exists. The highest probability of ferro resonance over voltages occur when ungrounded primary windings are fed by underground cable circuits that are switched remotely one phase at a time.

4-Transformers with ungrounded secondary windings, such as with the Delta or open Delta and floating wye connections, **may under certain conditions have voltages as high as those of the primary supply system appearing from terminal to ground, such voltages can result in danger to life and property.**

5-The transformer and its accessories must be operated within their required rating..

6-Operation of a primary protective device may indicate a faulted transformer. Do not re-energize if any signs of failure is observed. Re-energizing should be performed from a remote location unless the cause of device operation is positively identified and corrected.

7-If there are any signs of leaking oil, broken parts or other conditions that may be hazardous to the proper operation of the transformer, remove the transformer from service and consult the factory for the proper service. The correction of the problem must be acted upon before the unit is placed back on line.

2.3 Last minute checks -The following checks should be performed:

1-Has the incoming voltage been verified for the proper tap setting of the transformer ?

2-Have all hand tools and un-required debris been removed from the connection area ?

3-Is the liquid level at the proper operating position?

4-Has the insulating liquid been checked for a minimum dielectric strength of at least 30 Kv ?

Consult the factory if the test is lower.

5-Be sure all personnel are clear of the transformer before voltage is applied.

6-Has all phase barriers and required insulation barriers been put back in place?

7-If the transformer has been successfully energized, before leaving the area be sure all safety locks and doors are secured.

A. Close the high voltage compartment door and secure the mechanical locking device. This will be a hex head bolt or other mechanical device.

B. Close the low voltage door and turn the handle on the door securing the three point locking device. When the handle is in the vertical position

C. Place the penta-head bolt in the provided mounting position. Once this is secure, place the padlock (provided by others) in the proper position provided and secure the door.

D. Final check of the doors should be made for proper security and integrity of the high and low voltage cabinet.

8-After the unit is energized maintain an inspection or any sign of abnormal operation for the first eight **(8)** hours.

WARNING: FAILURE TO PROVIDE PROPER SECURITY OF THE TRANSFORMER COMPARTMENTS CAN ALLOW ACCESS BY UNAUTHORIZED PERSONNEL WHICH CAN RESULT IN INJURY OR DEATH AND DAMAGE TO PROPERTY.

2.4 Oil filled transformer loading-

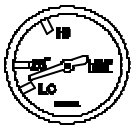
1-The transformers are designed to be used in a 30 Degree C ambient average temperature. The unit may be used in a 40 Degree C ambient for very short intervals. Unless it is a specially designed unit with the properly upgraded insulation level which can be operated at a higher temperature rating.

2-In areas above 3,300 ft. Above sea level reduced capacity will be required. Due to the air density the cooling efficiency of the transformer is reduced. Contact the factory for the capacity reduction or the ANSI standards for the proper rating for your unit.

3-A schedule should be made for periodic checks of the load applied to the transformer to verify excessive load is not being applied to the unit. Overloading should be in accordance with ANSI Loading Guide (C57.92).

The transformers provided are built in accordance with ANSI standards applicable to the design of unit provided.

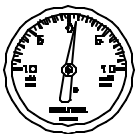
PART 3. COMPONENTS AND ACCESSORIES



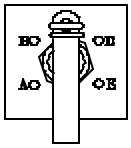
LIQUID LEVEL GAUGE The liquid level gauge is mounted on the front wall of the transformer in the low voltage compartment. This device shows the level of the insulating liquid . The 25 Degree C indicator will rise or fall according to the loading of the transformer and the ambient conditions. In some cases the unit will have a set of alarm contacts which activate on low level. The liquid level gauge is a field replaceable part if required

DIAL TYPE THERMOMETER The dial type thermometer is mounted on the front wall of the transformer in the low voltage compartment. The dial is laid out in Degrees centigrade and the hands are black for the existing temperature and red for the maximum temperature since the last reading. The red hand can be reset by turning counter clockwise on the middle knob of the face plate. The unit can be supplied with contacts for alarm purposes and cooling fan operation. If contacts are supplied the rating are:

10 amps @ 125,250 VAC
1/2 amps @ 125 V d.c.
1/4 amps @ 250 V d.c.
Color code meets ANSI C57.12.10



PRESSSURE VACUUM GAUGE The pressure vacuum gauge is mounted on the front wall of the transformer in the low voltage compartment. The gauge is monitoring the gas space above the oil level in the tank. This is to verify whether it is under a positive or negative pressure. It is calibrated in pounds per square inch and is labeled for plus or minus 10 PSI.



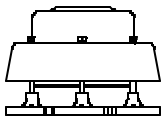
TAP CHANGER The tap changer **MUST *NOT* BE OPERATED WHEN THE TRANSFORMER IS *ENERGIZED*.** The tap changer is pad-lockable to allow only authorized personnel to operate the accessory. The unit has five (5) settings to adjust the ratio at 2.5% increments. The transformer is normally sent with the tap position set for the nominal voltage. If requested in advance, the proper setting can be made the factory before shipment. For changing positions the following procedure should take place:

A.- **De-energize** the transformer.

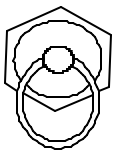
B.-Back out the locking mechanism and turn the handle to the desired tap setting. The nameplate will indicate the correct voltage for the tap number or letter setting required.

C.-Make sure the locking mechanism is secure in the proper position.

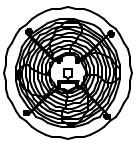
D.-Re-energize the transformer and check the voltage for the proper rating.



PRESSURE RELIEF DEVICE When required or specified, the transformer shall be equipped with a top mounted pressure relief device. This device will vent tank gases when excess pressure over the set point rating, if reached. The pressure level will be indicated on the nameplate of the device. The unit is self resetting, but the mechanical operation indicator must be manually reset after operation. This will notify the service technician of each previous venting. The unit can be furnished with alarm contacts. The alarm switch will require manual reset after each operation, refer to the nameplate of the device for the contact rating.

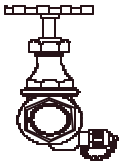


PRESSURE RELIEF VALVE The purpose of the pressure relief valve is to relieve excess internal pressure. Whether for gas build up or so access can be made safely to the hand-hole cover without the pressure on the unit. To operate, grasp the pull ring on the end cap with a hot stick and slowly pull the ring until pressure is relieved.

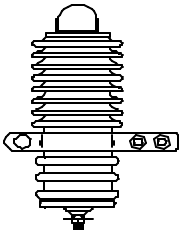


COOLING FANS Fans are occasionally required to provide additional loading capacity of the transformer without overheating the windings. Normal mounting positions for the fans are on the side or top of the cooling fins or radiators. Fan motors are equipped with drain plugs that are removed at the factory when installed. If they are field installed be sure to remove the drain plugs. The fans are normally connected to an automatic control unit mounted on the front wall or compartment barrier on the low voltage

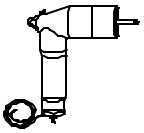
compartment. The control unit receives its signal from the dial type thermometer or the winding temperature indicator with alarm contacts. The control voltage is usually supplied from an external source.



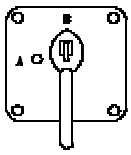
DRAIN AND SAMPLE VALVE The drain valve with sampler device is located at the bottom of the front wall of the transformer in the low voltage compartment. The valve is used to drain or to be used in the filter process of the oil if required. The sampler is used for checking the oil quality under routine tests. **Note: Never use the valve as a lifting mechanism.**



LIGHTNING ARRESTER The lightning arresters are used to interrupt or direct to ground over voltage transients from lightning or other sources on the distribution system. It is a protection device which is recommended for all outdoor or indoor installations. The rating of an arrester depends on the system voltage. Follow the recommended requirements of the arrester manufacturer.



DEAD FRONT ARRESTER The dead front arresters are a metal oxide varistor in a pre-molded rubber elbow. This is a fully shielded and insulated device for dead front application. Proper grounding connections should be paid close attention.



Dual voltage Switch DO NOT change the switch position when the transformer is **ENERGIZED!**
The dual voltage switch has two positions. Position **# 1** is the lowest or multiple voltage position. Position **# 2** is the highest or series voltage position.

To change voltage positions:

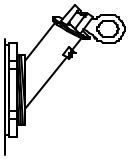
A. ***De-energize the transformer***

B. Back out the locking mechanism and turn handle to the desired voltage setting. The nameplate will indicate the correct voltage and tap number or letter setting for desired voltage. **Check the setting carefully** to make sure you are not re-energizing the transformer at a higher voltage the change was made for.

CAUTION: IF THE DUAL VOLTAGE SWITCH IS SET IN THE LOWER VOLTAGE POSITION AND THE HIGHER VOLTAGE IS APPLIED, THIS MAY CAUSE FAILURE OF THE TRANSFORMER, PERSONAL INJURY OR DEATH.

C. Make sure the locking mechanism is in the secured and proper rating position before voltage is applied to the transformer.

D. Re-energize the transformer and check the voltage for proper rating. If the voltage needs to be adjusted see the tap changer operation requirements for proper adjustment of the taps.



Bay-o-net fuses ***THE TRANSFORMER MUST BE VENTED PRIOR TO REMOVING THE BAY-O-NET FUSE FROM THE ASSEMBLY.***

The bay-o-net fuse assembly is a load-break device. The fuse unit is removed by a hot stick device. This is a dead front individual phase disconnect device which allows the replacement in the field of an under-oil expulsion fuse. The Bay-o-net fuses are either a fault sensing, current sensing or both type of fusing device. To operate or replace a fuse proceed with caution following the listed guidelines:

THIS IS ONLY TO BE DONE BY A TRAINED PROFESSIONAL !

A. Vent the transformer through the pressure relief device.

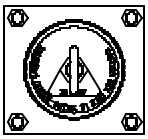
B. Attach the hot stick device in the unlocking hook of the bay-o-net fuse assembly and twist 90 Degree to the unlocking position to break the adhesion seal between the gasket and the bay-o-net housing. Pull the fuse holder assembly up approximately six inches to open the circuit.

C. Allow the excess oil to drain off the fuse assembly prior to removing the fuse holder completely from the tank. After removal of the assembly, install the replacement fuse per the manufacturer's instruction information.

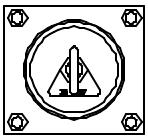
D. To reinstall the assembly rapidly push the fuse assembly in until it is fully seated against the housing

seal.

E. Push down on the locking handle and rotate making sure it hooks over the shoulder of the fuse housing.



Dry well Cannister fuses Load break and Non load-break draw out fuse assemblies.



Load-break fuse holders This load-break device is a combination of a dry well unit with a current limiting fuse. Load break fuse assemblies are equipped with an Arc quenching device inside the cannister assembly. This device allows the cannister fuse assembly to effectively become a switching device if required. This is an inexpensive way to eliminate the requirements for a separate switch to remove the transformer coil assembly from energization. Removing the fuses then allows the low voltage section to be de-energized for work or changes in the system that may be required.

Note: In some cases the dry well cannister may be mechanically interlocked with the LBOR switch if installed.

These are the basic instructions for replacing the fuse:

A. Connect the hot stick assembly to the hook eye on the front of the individual fuse assembly. With a quick smooth motion that may require some force, withdraw the fuse assembly from the housing. Do not turn the fuse holder make sure it stays in a straight position.

B. With the NX style fuses, the fuse may be replaced by removing the set scres at the end of each fuse body then remove the old fuse and replace with the same style and type of fuse as originally supplied by the factory.

C. Fuses from different manufacturers may have a style fuse that screws directly into the fuse.

Note: Changing the fuse from the original rating must be authorized by the factory while the unit is under warranty. If you do not have authorization this can void the warranty of the transformer or cause possible damage to the unit under fault conditions.

D. After the fuse unit is installed back to the contact and holder assembly, the unit is ready to be reinstalled back into the fuse housing. Connect the hot stick to the hook eye on the front of the fuse contact assembly and insert the fuse holder until the spring contact have fully entered the housing.

E. Quickly and smoothly with a minimal amount of force push the fuse assembly in a straight line into the housing until it is completely seated against the housing and the ground clip assembly.

Non load break fuse holders The non load break design fuse holder is not equipped with the Arc quenching device that is in the load break style units. There for the transformer must be de-energized before changing the fuse assembly. The transformers equipped with this style fuse in most cases are equipped with a LBOR switch which can be mechanically interlocked with the fuses to allow access only after the switch is in the open position. Other than the load break capabilities it provided the same ease of use and cost savings as the load break style assembly.

DANGER: ***DE-ENERGIZE THE TRANSFORMER BEFORE REMOVING OR INSTALLING THE DEAD-BREAK FUSE DEVICE. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, PROPERTY DAMAGE OR DEATH.***

These are the basic instructions for replacing the fuse:

A. If the fuse canisters are interlocked with the LBOR switch, by use of a hot stick device place the stick in the switch eye bolt connection and turn to the off position. The mechanical interlock can then be moved and the fuse housings accessed.

B. Connect the hot stick assembly to the hook-eye on the front of the individual fuse assembly. With a quick smooth motion that may require some force, withdraw the fuse assembly from the housing. Do not turn the fuse holder make sure it stays in a straight position.

C. With the NX style fuses, the fuse may be replaced by removing the set screws at the end of each fuse body then remove the old fuse and replace with the same style and type of fuse as originally supplied by the factory.

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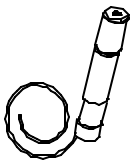
F. Quickly and smoothly with a minimal amount of force push the fuse assembly in a straight line into the housing until it is completely seated against the housing and the ground clip assembly.



Internal Weak link Fuses The weak link fuse is an oil immersed, expulsion design fuse assembly for use in the high voltage of the transformer circuit. The purpose of the fuse is to remove a defective transformer from the incoming circuit. This is design to also limit the damage that may have been caused by an internal fault. The fuse is a construction of a Hard fiber tube with an internal fuse wire element. The fuse wire is welded to a copper terminal on the fuse end and connected to a braided copper wire on the lead end. These fuses are mounted in the internal tank area and must be accessed through the hand hole cover.

These are the basic instructions for replacing the fuse:

DANGER: ***DE-ENERGIZE THE TRANSFORMER BEFORE REMOVING OR INSTALLING THE FUSE DEVICE. FAILURE TO DO SO CAN RESULT IN SEVERE INJURY, PROPERTY DAMAGE OR DEATH.***

A. De-energize the transformer.

B. See the instructions for **Minor repairs-Internal access** and follow the directions for entrance in to the tank of the transformer.

C. It may in some cases, require the oil level of the unit to be lowered to access the fuse.

D. As with the blowing of any fuse, basic tests should be ran on the transformer before re-energizing the unit.

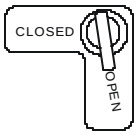
E. Once the oil is lowered the when facing the front of the transformer, the weak link fuses should be located on the left hand side close to the front when going through the hand hole. The fuse will be bolted to a fiber support on the frame of the transformer.

F. Locate the failed fuse and disconnect the terminals to allow removal of the fuse. There will be a clip around the body of the fuse which will require unbolting to release the fuse.

G. Replace the fuse in the reverse operation of the removal process. Replace only with the same rating fuse unit unless other wise instructed from the factory.

H. After the fuse replacement be sure to clean the area of all contaminates (if any) and proceed with the refilling of the oil and the required procedure for the **Minor repair-internal access instructions.**

Rapid Rise Relay Indicates the buildup of excessive gas generated from internal arching. When then pressure builds up, it will initiate an electrical signal for the breaker operation to de-energize the transformer and institute an alarm if required. The changes in the internal pressure activate the sensing bellows and the responding bellows which are a part of the sealed system.



Two position Load-break oil rotary switch (LBOR). This switch incorporates a manually charged over-toggle spring charged stored energy operating mechanism. This provided a quick make and break operation. This switch is operated with a hook-stick assembly which requires minimal torque to operate. The switch has been tested to two thousand operations. If replacement is required, this should be done at the factory or by an authorized repair facility.

Part 4- GENERAL MAINTENANCE AND MINOR REPAIR

4.0 General Maintenance

A regularly scheduled maintenance procedure should be established on all electrical equipment and transformers. At regular intervals, the general condition of the following should be evaluated for proper care and operation:

WARNING: *BEFORE ATTEMPTING TO MAKE ANY INSPECTION REQUIRING ACCESS TO THE CABINET INTERIOR. THE TRANSFORMER SHOULD BE DE-ENERGIZED AS A SAFETY PRECAUTION.*

Note: ***See Energizing cautions before any inspection requiring the operation of any device or connection involving the correction of a problem with the transformer.***

4.1 Bushings. High and low voltage bushings should be inspected for cracks or excessive corrosion, possible heating of the insulation of the conductor, leaks of oil from the bushing end or location of the tank where the bushing meets the gasket. Check the bushing clamp for proper torque setting.

4.2 Ground connections. The ground connection should be inspected for proper connection and level of corrosion. If corrosion is found on this cable. Disconnect the transformer from the main power supply and proceed under normal high voltage precautions taken. The cables should be cleaned with the proper solvent and replaced taking care to make a solid ground connection to the grid.. Then remove all unnecessary tools from the area before re-energizing the transformer.

4.3 Safety labels. Inspect all safety labels to make sure they are clear and legible condition. Make sure all required labels are present such as Danger High Voltage, KVA capacity, NON PCB sticker.

4.5 Gauges. Check all gauges such as oil level, pressure vacuum and dial type thermometer for signs of leaks around fittings, damaged site glass and general integrity of the indicating device hands and contact assembly. If any are found to be defective replace and re-gasket or seal.

4.6 Enclosure. Check the enclosure integrity to make sure it has not been compromised. Verify that all hinge assemblies, locks, external provisions and exterior of the unit is not rusted or corroded to the point of unacceptable level of safety. If the unit is rusted, clean the effected area as required. For all metal exposed to the environment, repaint with the proper primer and finish coat. Lubricate
hinges as required.

4.7 Location. Verify that the original location the transformer was placed in has not been compromised due to settling of the soil or shifting that may cause the unit to tilt beyond the manufacturers limit. This can also cause an opening where access may be gained by unauthorized personnel, which could be a hazard to life and property.

4.8 Basic tests Oil. The oil level of the transformer should be inspected and the maximum temperature reached between inspections should be recorded in a log book to establish a history on the transformer. A sample should be taken every six months to one year to establish the integrity of the oil and the insulation of the transformer. The following are basic test that are a minimum:

4.8.1 Oil tests

Dielectric strength	Color
Interfacial tension	Karl Fisher
Specific gravity	Acid

Yearly- Dissolved Gas analysis

Other tests.
(Authorized service personnel only)

4.8.2 For drawing oil samples: A large mouth glass bottle with a cork or glass stopper should be used for collecting samples of transformer oil. Before using the bottle, clean it with Xylene or other non-residual solvent and dry it well. Rinse the container several times with the oil to be tested before collecting the sample. If a dielectric test only is to be made, one pint of transformer liquid will be sufficient; however, if other tests are to be made, drain off one quart before the sample is taken. This is to remove any moisture which may have accumulated in the pipes.

4.8.3 Megger. If the above tests indicate a possible moisture problem, the electrical technician should run a megger or insulation resistance test on the transformer.

This test is to verify the insulation integrity of the transformer. Regular insulation resistance measurements provide a reference point for any changes in the insulation due to moisture accumulation or chemical deterioration. Insulation resistance and power factor measurements are also important during the drying of a transformer or its oil.

Precautions:

A. Every measurement should be taken carefully, using the same procedure in each case to be consistent.

B. Do not use an instrument having a voltage output in excess of the voltage rating of the winding being tested. The readings should be recorded every two hours when drying a transformer by use of circulating current . When vacuum drying, take readings after each vacuum period, before and after filling with oil.

C. Before taking measurements, be sure to clean and dry all connection points, dirty porcelain or electrical connections can result in low readings.

Insulation resistance can be measured with a megger or megohm bridge. Be sure the scale of the megger can reads higher than the insulation resistance being measured.

Insulation resistance measurements will vary from each transformer measured. For new equipment an approximate minimum value for insulation resistance is 25 Megohms per kV of rated line to line voltage.

4.8.4 T.T.R. A turns ratio test is also a good maintenance test to run. (**See tap changer information in parts section before testing**) This test verifies the ratio of the coils of the transformer has not changed since installation. If the ratio has changed, there may be an internal problem with the tap changer or the coil assembly and connections.

This test will also verify proper operation of the tap changer through all voltage settings.

4.8.5 Hi-pot. This test also checks the major insulation integrity of the transformer to ground and all other windings. The test applies voltage in excess of the normal operating voltage. This voltage stresses the insulation beyond the normal limits to establish the transformer is suitable for the application.

5.0 Minor Repairs

WARNING: Before attempting any repairs to the interior of the cabinet or internal components refer to the warning information on each component. De-energize the transformer and vent the pressure relief device. Failure to follow the required directions can result in severe injury, death or property damage.

1. Report all failures or component failure to your Delcor Power Representative immediately. All repair during warranty must be preformed by an authorized representative or approved service technician. **If this is not strictly followed your warranty could be void!!**

2. To assure proper operation and compliance use o only factory authorized components and parts.

3. It is recommended that the owner of the transformer limit the repairs or replacement of broken or failed components, to only qualified and well trained personnel with repair experience.

5.1 Repairs without internal access. The following are repairs with can be made without the access of the internal components:

1. Bayonet fuse replacement should be made according to the instructions under Bay-o-net Fuses in the components and accessories section of this instruction manual.

2. Dry well fuses come in two different types. There are load break and Non-load break designs. The procedure for changing the fuse is located in the components and accessories section of this instruction manual.

3. Clip mount fuses can be accessed after the unit is de-energized. The fuses are removable according to standard procedures and safety precautions normally required for any high voltage fuse application. This fuse can be removed by a hot stick if equipped high

the proper hook eye. Most fuses of this nature are a barrel design and can be removed by hand with the proper safety protection.

4. The temperature gauge is located in a well on the tank wall in the low voltage side of the transformer. This gauge is removable from the outside by loosening the nut on the back of the gauge while holding the nut on the well to keep it from moving and breaking the seal it has on the tank.

5. Replacement of the live front lightning arrester must be done with the unit **de-energized.** This is a simple operation requiring the disconnection of the conductor to the high voltage bushing and the ground connection. Finally the removal of the mounting bolts and loosening of the arrester can complete the removal. To reconnect an arrester mount the unit as normal requirements and replace the ground wire next, then the high voltage connection.

6. Replacement of the dead front arrester and elbow connectors should be handled according to the component manufacturers requirements supplied with the connector.

7. Replacement of the front sill, side panels, front doors, false cover**,** handle and hinge assembly are all factory items which can be replaced**.**

5.2 Internal access. Internal entrance to the transformer can be gained through the bolted access hand hole cover on the top of the transformer tank. Remove the false cover by accessing the bolts in the low and high voltage compartment. After these bolts are removed the false cover can be taken off for access to the hand hole cover. The cover bolts should be removed and placed away from the top of the transformer. All tools that are not secured should also be removed so not to fall into the open transformer. If any foreign item falls into the tank and is not recovered, it could cause failure of the transformer or physical harm or damage to the equipment. The surrounding atmosphere must be dry and free from moisture so as not to contaminate the insulating liquid of the transformer.

1. The oil level of the transformer tank in most cases will need to be lowered past the component that internal access was required for. It is important not to remove any more oil than absolutely required. When the oil is being removed it should **only** be placed in a **clean**, dry location. Try not to lower the level below the top of the core and coil assembly.

2. Bushing gaskets can be replaced only with access to the internal of the transformer. Loosen the nuts securing the primary or secondary conductor, being careful not to drop any of the securing washers or nuts. After the internal end is disconnected then the external bolts can be removed. Pull the bushing clamp off the end of the bushing and remove the bushing assembly away from the tank wall. Be sure to clean away the old gasket material and glue to give the proper seal for the new gasket. Be careful to replace the gasket only with the same type and thickness of material supplied for the original gasket. Proceed with the same process in reverse making sure the bushing clamp is tightened diagonally across rotation from each other until the proper torque setting is reached. Care must be taken to keep the gasket integrity in place and to not crack or chip the porcelain of the bushing (If applicable).

3. Internal current limiting fuses can be accessed from the hand hole cover although this is a job that is normally required to remove the top cover to access. The fuses will be mounted on top of the core and coil assembly in an insulated connection area. These fuses are normally supported by a insulation board attached to the frame. The fuse will have bolted connections at both ends tying one end to the bay-o-net fuse assembly or bushing connection as required. Remove the nuts taking precautions not to drop them in the transformer tank. Then take out the old fuse and replace with the new fuse and connect as required.

4. Internal weak link fuses can be replaced in much the same way as the internal current limiting fuse. These are usually much simpler to access.

5. The load break oil rotary switch can be accessed for inspection, but it is not recommended for field replacement,, as this is a factory installation in most cases.

6. The tap changer can be inspected but in most cases will require factory installation as there are many small nuts to remove that may be dropped to the interior of the transformer tank.

When ever an internal inspection is made, it is best to check all connections, cables, insulation, and the superstructure of the transformer for any signs which may indicate a future or present problem.

5.3 Oil Filling When all minor repairs that can be completed in the field are finished, the oil can then be re-introduced to the transformer.

When filling a transformer with liquid, always filter the oil to prevent dirt, lint, and moisture from entering the tank. The level of the oil shall be replaced up to the level required by indication on the oil level gauge at the 25 Degree C mark. If a gauge is not provided, then it should be filled to the proper level at the level plug position.

A filter press is the most effective way for removing types of contaminates, including fine carbon and small deposits of moisture. Always begin the filtering process with new filter paper and replace it frequently, depending upon the amount of moisture removed. Filter paper must be thoroughly dried and kept warm until the time it is used.

If tests show the presence of a large quantity of moisture and dirt, it may be required for several passes through the filter press. In some cases heating of the unit may be required, as the moisture content may be to high for actual reduction in the field. If this is the case consult the factory for the best recommendations.

When water and dirt have been removed so that the oil tests 30 KV or greater, change the filter connection to the upper filter press valve and return the liquid to the top of the transformer.

5.3.1 Non-Vacuum Filling In cases where vacuum filling is not required, the tank should be filled through the upper filter press connection. A second opening above the oil level should be provided to relieve the air being displaced. The transformer should not be energized for a period of 48 hours after filling.

5.3.2 Vacuum Filling Trapped air is a potential source of trouble in all transformers. It is desirable to fill transformers with liquid under as high a vacuum as transformer permits. The transformer tank must be air tight, except for the vacuum and oil connections. After obtaining a vacuum as high as the tank construction will allow, it is best to keep this vacuum continuous pumping for at least three to four hours. The filling of the unit may then begin. The liquid line should be connected to the upper filter press connection at the top of the tank. The filtered liquid is admitted through the connection with the rate of flow being regulated by a valve at the tank so that the vacuum does not fall below 90 percent of the original amount pulled on the unit. The vacuum should be maintained for three or four hours after the transformer is full.

CAUTION: DO NOT allow transformer liquid to enter the vacuum pump.

5.4 After Internal Inspection: Proceed with the replacement of the hand hole cover. During this process check the gasket to make sure of its integrity. If found to be unacceptable, replace as required making sure as to remove all the old material to keep the integrity of the new seal complete. Re-bolt the cover and false cover as required.

If provided with a pressure bleeder valve, the unit should have introduced the proper nitrogen blanket required.

A check should be made on a regular basis during the next 48 hrs. This is to make sure the repair has taken care of the problem and further service is not required.

All other repairs which would be required, are not field repairs, these repairs must be completed at the factory.

6.0 Removing From Service If a unit is to be de-energized but not moved physically, there are no special requirements for shutdown. Follow instructions for "placing into service" when returning the unit to service. If the unit is to be moved, it will be necessary to remove all necessary detachable parts for proper handling. Shipping braces that might protect the assembly during movement should also be replaced.

7.0 Trouble Shooting

Problem	**Reason or Solution**
Excess Secondary Voltage	Improper tap changer setting or faulty tap changer
Overheating	Poor ventilation, Continuous Overload, Wrong external connections, Ambient temperature higher than design.
Reduced or No Voltage	Faulty tap changer, Loose internal connection, Shorted turns, Blown fuses, No incoming voltage.
Breaker or Fuse activation	Overload, Inrush current internal or external, Short Ciruit
Excessive bushing Heating	Incorrect bolted connection either external or internal
Insulation Damage	Continuous overloads, Lightning surge, Mechanical damage because of rough handling.
Oil pressure remain on zero	Faulty pressure gauge or pressure leak
Vibrations or Noise	Core clamps loosen in shipment or excessive input voltage
High exciting current	Shorted turns or excessive input voltage
Core overheating	High input voltage
Pressure relief device operation	Gas buildup due to broke connection arching, tap changer arching, Insulation failure
Burned insulation	Switching or line disturbance due to lightning or excessive voltage. Failure due to moisture or overheating
Bushing Flashover	Abnormal voltage surge or Possible environmental contaminants