PROLEC GE

Powering reliable solutions for you

Reception, installation, operation and maintenance manual for three phase pad-mounted transformers

GEI-79025M

Warranties

ProlecGE S. de R.L de C.V warranties the device herein specified against any bad practice in design, construction, material and workforce.

By this Warranty we promise to repair or replace, as it is necessary, F.O.B. factory, all equipment or part that is defectively in the term of 12 months after commissioning or 18 months after delivery, whichever occurs first and only when it is notified in a written form when the fault is discovered, detailing the fault found and the circumstances in which it happened.

BeingthisWarrantyagainstdesignfaultsormanufacture;ourcommitmentstayswithout effect in case of inadequate installation, operation or maintenance, or realized by not qualified personnel, as well as for accidental or fortuitous circumstances, such as the lack of suitable protection equipment for overcurrents, overvoltages or overcharges, lightning, fires, mistreatment in the transport or maneuver and when there does not exist evidence of satisfactory tests results before the energizing, etc.

To preserve the validity of this Warranty, modifications should not be done to the design or equipment characteristics, without previous factory authorization.

Product spare parts, components, consumable and accessories protected in this warranty, as well as more detailed information to claim the warranty can be obtained in the address showed below.

Reception, installation, operation and maintenance manual for Three Phase Pad-Mounted Transformers

INDEX

INTRODUCTION

To achieve a safety operation in three phase pad-mounted transformers and long field life, it is important to respect the nominal design characteristics, like capability (KVA), oil level, nominal operation voltages and the instructions found herein Reception, Installation, Operation and Maintenance Manual for Three Phase Pad-Mounted Transformers.

Since in mounted transformer operation can be present dangerous conditions; this manual outlines the CAUTION notes for the activities that need special care, as the following one:

CAUTION
Read this manual carefully before you receive, install, operate or give maintenance to the three phase pad-mounted transformer. **Keep this manual near to the pad-mounted transformer location.** **Any work that involves the use of a pad-mounted transformer, must be carried out by qualified personnel.**

1. SHIPMENT

GE PROLEC three phase pad-mounted transformers are shipped hermetically sealed.

2. RECEIVING INSPECTION

A meticulous inspection of the three phase pad-mounted transformer during reception must be done before unloading from transportation (trailer platform or truck). Check that the transformer requested characteristics match those indicated in the nameplate.

Immediately after equipment reception, and before putting it into service, inspect the transformer for any damage that may have occurred during shipment or storage. If rough handling is evident, fill out a damage claim with the transport company immediately and notify PROLEC GE representative.

NOTE: A visual inspection will be requested of the interior of the three phase pad-mounted transformer only when there is evidence of physical damages from the exterior, and in such situation it will be necessary to communicate the requirement to a PROLEC GE representative, and to a transporter representative, before beginning with the inspection works.

In case of having a bolt with spring lock, it is needed a 18mm hexagonal socket to open the cabinet for the low voltage side. In case of having an opening and closing handle and a lock type “G” a key will be provided by PROLEC GE.

A report of the conditions in which the equipment and its accessories were received must be done for any claim.

3. HANDLING

3.1 Transformer

The transformer always must be lifted or held from the four lifting lugs in vertical position unless it is indicated in any other way. When a derrick cannot lift the pad-mounted transformer, it can be slipped or moved on rollers inside the place, only when the floor allows it. During the maneuvers, special care is needed to avoid overturning.

When the transformer is located in its final place, the external wood protections must be removed.

3.2 Lifting

The lifting lugs are designed to allow the lifting with a maximum angle of 30° between the sling and the vertical. When lifting with wider than 30° angles regarding the vertical, an extension bar must be used for the vertical rising, between the slings.

CAUTION!
The cover tank lifting lugs must be used only to raise the cover tank in individual form. The lifting lugs be used never to lift the complete transformer. To avoid transformer damage lift the pad-mounted transformer from the four lifting lugs. Do not raise the transformer from drain valves, pipeline connections nor radiators.

4. INTERNAL TRANSFORMER INSPECTION

It will only be carried out in the presence of Prolec GE representative or with authorization written.

5. STORAGE

If pad-mounted transformer is not immediately installed, it is advisable to locate it in a safe place, complying with the following points during its storage:

- Look for chips or flaws in the surface and apply painting in damaged surfaces, preparing the surface with sandpaper.
- If the three phase pad-mounted transformer is indoor type and for some situation it will be stored in outdoors area, it must be covered with some means that allows protection of environment conditions.
- Avoid contact with vapors or corrosive gases as the chlorine and sulfur ones.
- The spare parts that are given with the three phase pad-mounted transformer have to be keep on a clean and dry place.

6. LOCATION

The three phase pad-mounted transformer location should provide enough space: a) to allow the installation maneuvers, b) to have access to pad-mounted transformer at inspection and maintenance tasks, and c) to have good ventilation.

The self-cooled three phase pad-mounted transformers depend entirely on the air that circulates in their surroundings for heat dissipation. As mentioned above and in the case of indoor installations, the room where the transformer is located should allow good ventilation, in such a way that the hot air can be replaced by cold air. For the above mentioned, it is recommended that the openings of entrance of the room be near the floor while those of exit are in the superior part of the three phase pad-mounted transformer.

The self-cooled transformers will always be separate from another, from adjacent walls, divisions, etc. so that the free circulation of the air is allowed among the tanks. This separation will be of 0.75 meters, as minimum.

7. SERVICE PREPARATION

7.1 Oil level

The three phase pad-mounted transformer is filled with oil up to its nominal level from factory, taking in consideration the ambient temperature at the moment of being filled.

7.2 Audible sound emissions

All the transformers generate audible sounds when they are energized; this is due to the mechanical vibrations generated by the magneto-striction phenomenon present in the core. However, the noise level should not reach levels that cause annoyance to those who remain temporarily near the transformer.

7.3 Low voltage and high voltage electrical connections

The cables that are connected to the transformer bushings should be long enough to allow their expansion and contraction due to temperature changes.

It is important to verify that the connections are very tight to avoid hot spots generation, or the transformer terminals are disconnected due to pad-mounted transformer characteristic vibrations. On the other hand it must be assured that the weight and alignment of the cables connected to the bushing will not bring about mechanical stress that can cause crack, failures or to provoke the presence of leakages through the gaskets.

7.4. Ground connections

The transformer must be permanently ground connected in order to avoid electrical discharge by an induced voltage. The connection has to be made through the tank ground pad.

The ground system must be carried out with the particular regulations of the area where the transformer has been installed.

CAUTION!
Never make connections that are not authorized by the manufacturer or are not indicated in the Nameplate.

8. INSTALLATION

Before applying voltage to the transformer check the following:

The neutral terminals (X0 or H0) are properly ground connected. Note: Excepting floated systems as Y-Y.

- The tank is solidly grounded.
- The tap changer has the adequate position to provide the relation of needed voltage
- All the tools or strange objects have been removed from the transformer.
- All the manhole and hand hole are properly covered.
- Any bolted connection i.e. H.V. bushings flange, etc are properly tightened.
- No oil leakages or stains are present
- The oil level is the correct one.
- All levels, oil and temperature are correct.
- All the electric connections are properly tightened.
- General cleaning is made and especially the bushings porcelain (see maintenance chapter).
- The bushings are in good conditioin (without blows or fissures).
- People are not near to the three phase pad-mounted transformer previous to be energized.

If the transformer has been stored more than six months it is recommended to run the following field tests:

- Verify the isolation resistance of each winding to ground and between windings.
- Verify power factor of each winding to ground and between windings.
- Turn ratio shall be determined for all taps and for the full windings.
- Verify that the dielectric strength of the insulating liquid remains with values superiors to 30kV/mm.

8.1 ACCESORIES AND COMPONENTS

The knowledge of the accessories and the way in which they protect to the three phase pad-mounted transformer, will give a bigger security to operatives and a long field life.

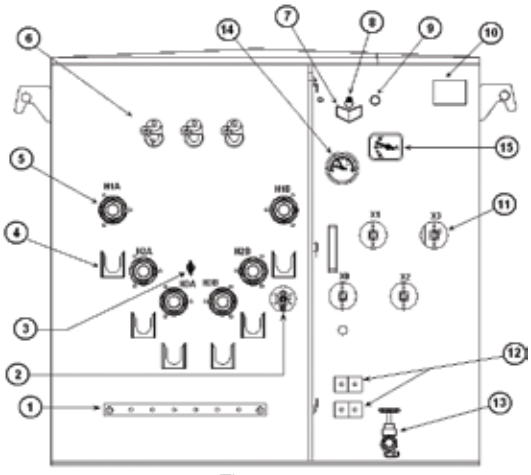


Figure. 1.
Pad-Mounted Transformer, loop operation.

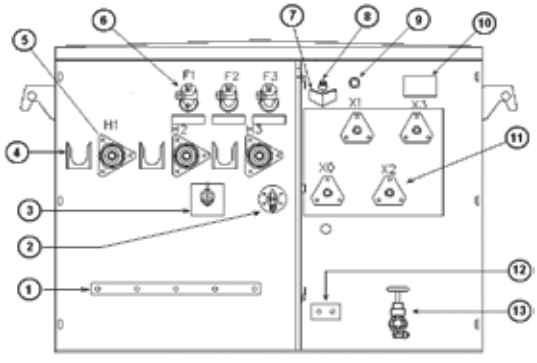


Figure. 2.
Pad-Mounted Transformer, radial operation.

ACCESORIOS	
1. Copper bar for connections to ground. 2. Tap changer. 3. Radial or Loop Feed Switch. 4. Parking stand. 5. High voltage terminals. 6. Bayonet Fuseholder. 7. Drip shield to contain oil.	8. Manual and automatic overpressure valve. 9. Nipple with female plug for hermetic test. 10. Nameplate. 11. Low voltage terminals. 12. Ground connectors. 13. Drain and sampling valve. 14. Oil temperature gauge (Only in > 150KVA). 15. Oil level gauge (Only in> 150KVA).

8.1.1 Feed-switch

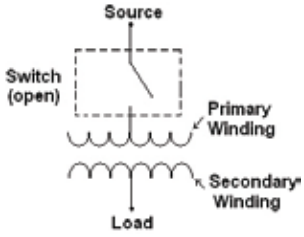
Most of the three phase pad-mounted transformers have feed-switch. The feed-switches are on-load operated switches. To operate the feed-switch the hot-line tool is placed in the feed-switch and turned to the desired position.

For their function there are two kind of feed-switch:

8.1.1.1 Radial feed switch

The radial-feed two position internal oil switch, shown in Figure 3(a), is a gang operated loadbreak switch. It is operated by hot stick and uses a manually charged overtoggle storage spring assembly that is independent of operator speed. The spring loaded operating mechanism ensures quick load breaking and load making operation. It can be used to de-energize the transformer. The operating handle a nameplate are located in the high voltage compartment. Figure 3(b) is a schematic of this switch.

a)



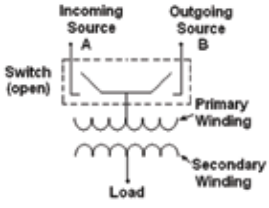
b)

Figure 3. a) Radial Feed Switch.
b) Schematic of the Radial Feed Switch.

8.1.1.2 Loop feed switches

The loop feed switch arrangement, shown in Figure 4(a), consist of two positions, gang operated, internal oil switches. It may be used for sectionalize and loop connections, such as selection of power sources in a loop feed primary distribution system, isolating faulted cables or transformers, or isolating transformer when changing it out or during maintenance. Six high voltage bushings are furnished with a typical application. Three bushings are identified as A source and three as B source. Figure 4(b) is a schematic of this arrangement.

a)



b)

Figure 4. a) Loop Feed Switch
b) Schematic of the Loop Feed Switch.

The switch positions are as follow:

a) Both pointers CLOSED. This position permit loop feed for adjacent transformer with he transformer energized.
b) Left-hand pointer CLOSED, right-hand pointer OPEN. Only one side of the loop (A bushings) is connected to the transformer windings.

c) Left-hand pointer OPEN, right-hand pointer CLOSED. Only one side of the loop (B bushings) is connected to the transformer windings.
d) Both pointers OPEN. Both sides of the loop (A and B bushings) are disconnected, thus isolating and de-energizing the transformer winding from the loop feed system.

8.1.1.3 Loop-radial switches
Two position loadbreak switches, shown in Figure 5, may be used to obtain a combination of the loop and radial switch functions. The combination consists of a transformer switch (line B) and a loop switch (line A).

The switch positions are as follows:

a) Both pointers CLOSED. The loop is closed by connecting line A to line B, and the transformer is connected to the loop.
b) Left-hand pointer CLOSED, right-hand pointer OPEN. The loop is open and the transformer is connected to source A.
c) Left-hand pointer OPEN, right-hand pointer CLOSED. The transformer is disconnected from the loop and the loop is closed.
d) Both pointers OPEN. The transformer is de-energized and the loop is open.

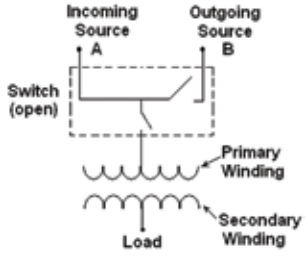
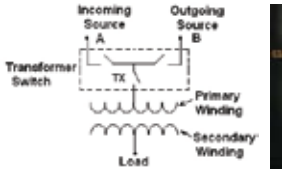


Figure 5. Schematic of the Loop-Radial Feed Switch.

8.1.1.4 Loop switch with ON-OFF radial switch
This combination, shown in Figure 6, provides the function of the loop and radial switches, allowing the transformer to be de-energized and either loop to be opened.

a)


b)

Figure 6. a) Loop switch with ON-OFF radial switch
b) Schematic.

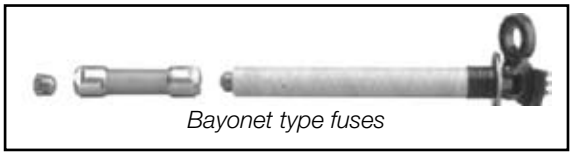
8.1.2. Expulsion fuse

8.1.2.1 Bayonet type
The device where the expulsion fuse is placed receives the name of bayonet (Fig. 7), and it is accessible from the exterior of the tank. The expulsion fuse acts in fault cases in the secondary side of pad-mounted transformer or for overloads higher to the acceptable for the Norm NOM-J-409 and ANSI C-57.91. To replace the fuse (Fig. 8) from the exterior, follow the next instructions:

1. De-energize the transformer and verify that there is not voltage in low voltage bushings.
2. Open the doors or access cover in front of the instruments (high voltage side).
3. Activate the pressure-relief valve, pulling the ring in order to eliminate the internal pressure.
4. Attach hot line tool to handle eye.
5. Unlock the handle and rotate 90° clockwise in the housing.
6. Jerk the bayonet out approximately 10 to 15cm,. Wait few seconds in this position in order to drain the oil.
7. Take out the bayonet totally.
8. Unscrew the fuse holder cartridge and extract the fuse element.
9. Remove the fuse and install the new fuse, verifying that coincides with the catalog number that is indicated in the nameplate.
10. Set the bayonet in its place.
11. Fasten the bayonet inverting the process to remove it (points 4 and 5).

Bayonet type assembly

Figure 7.

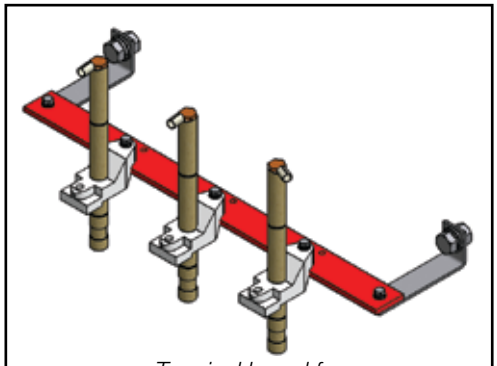


Bayonet type fuses

Figure 8.

8.1.2.2 Terminal board type

This type of expulsion fuse is placed in the rear wall of the tank, placed in a material called “Glastic” (Fig. 9), and is not accessible from outside the tank. The expulsion fuse acts in fault cases in the secondary side of pad-mounted transformer or for overloads higher to the acceptable for the Norm NOM-J-409 and ANSI C-57.91. To replace the fuse (Fig. 9) from the inside, you should call a technician.



Terminal board fuses.

Figure 9

8.1.3. Current limiting fuse

8.1.3.1 Partial Range Current Limiting Fuse (PRCLF)

This type of fuses operates for transformer internal faults, and it is placed inside the tank.

When this type of fuses operate, the diagnosis, unit repair and the fuses replace, must be carried out in a specialized workshop.

8.1.3.2 Complete range fuse

It can be installed inside the transformer in such case it is replaced in the same way that partial range fuse. A second type is used in transformers with Norm K (K0000-07CFE), it has a fuseholder, which allows to be removable from the exterior. These fuses have mechanisms that don’t allow the fuses to move away unless the transformer Radial Feed-Switch is opened.

To replace a Current Limiting Fuse removable from the exterior, follow the next instructions:

- Place the Radial Feed-Switch in “open” position in order to de-energize the transformer and remove the fuseholder.
- Eliminate the transformer internal pressure pulling the over-pressure valve ring.
- Attach the hot-line tool to handle eye and jerk it out.
- Replace the fuse for a new one; be sure that the characteristics are identical.
- Introduce the new fuse, and push it until its the correct position.

8.1.4. Insulating fuses

These fuses are used in some transformers. This kind of fuses does not have interruptive capacity, and for this reason are connected in series with an expulsion fuse. This scheme is designed to protect the operator that re-energizes a faulted transformer whose current is bigger than the fusible current interruptive capacity.

When this fuse operates, it is indicative that the transformer has an internal fault (mainly in windings) and it requires to be repaired in a specialized workshop.

8.1.5. Thermal or thermomagnetic switch

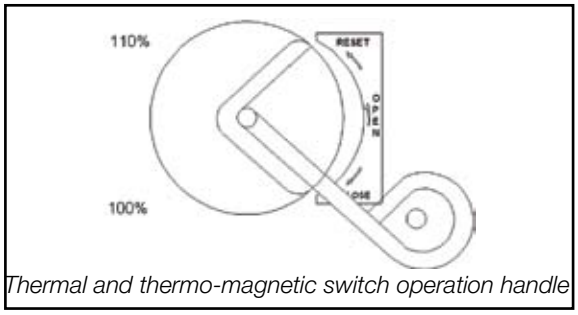
The thermal and thermo-magnetic switches are optional protection elements in the pad-mounted transformers.

This type of elements is used to protect the transformer from faults in low voltage side against short circuit currents and oil temperature over-elevation due to an overload.

The switches are operated from the exterior by means of an operation handle (Fig. 10) and a hot-line tool activates them.

The operation handle has three positions that are:

RESET
OPEN
CLOSE



Thermal and thermo-magnetic switch operation handle

Figure 10.

To open the switch, place the handle in the position “OPEN “.

To close the switch, when this operates for overload, the handle will be taken to the position “OPEN” (it should be taken until the position RESET) and then to the position “CLOSE”.

These switches have overload indicative lamp and an emergency control overloads lever.

Under an overload condition the lamp will turn on and it will still remain in this state even when the overload disappears. The indicative lamp can turn off if overload condition has disappeared and it is commuted the state of switch momentarily, when it is opened and closed.

The emergency control lever can be used to recalibrate the switch operation temperature. This operation decrease of transformer life, but it provides the immediate service restoration when an overload is not bigger than 10%.

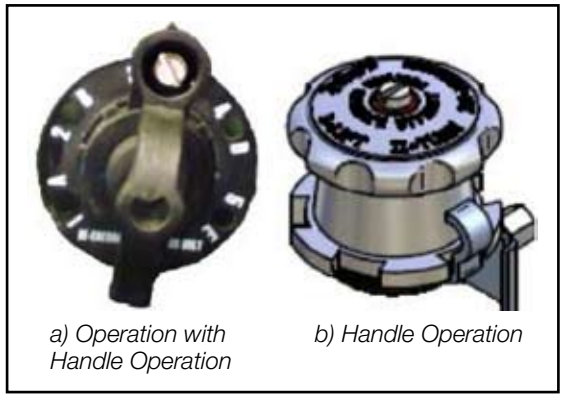
8.1.6. Tap changer
The tap changer is a device that allows making windings adjustments to compensate deviations in nominal voltage.

The tap changer operation could be made with hot-line tool or using the operation handle (Fig. 11). To operate the tap changer you must follow the next instructions:

1. De-energize the Transformer and prove that there is not voltage in low and high voltage bushings.
2. Remove the screw which is used to lock the operation handle.
3. Attach the hot line tool to handle eye tap changer.
4. Place the handle in the desired position. To increase the voltage in the low voltage terminal it is required to rotate it in clockwise.
5. Replace the screw to lock the operation handle
6. Once finished the above mentioned, proceeds to energize the transformer.
7. Finally, it should be verified that the voltage value is inside of the design values indicated in the nameplate, typically +/-5% about the nominal value. Superior values can generate transformer over-heating, increment the noise level, or a bad operation of the equipment that the transformer feeds.

Never try to put the tap changer in intermediate positions or any other position that is not clearly indicated in the nameplate.

DANGER!
De-energize the transformer before operating the Tap Changer. **Verify that the tap changer is in a correct and firmly position preventing any unwanted displacement.**



a) Operation with Handle Operation

b) Handle Operation

Figure 11. Tap changer

8.1.7. Dual voltage switch

The dual voltage switch is used to change connection of de-energized transformer windings between series and parallel to provide different common transformer voltage ratios.

8.1.8. Bushing insert threads

8.1.8.1 Bushing insert

The Bushing Insert threads into a universal bushing well to provide the same function as an integral loadbreak bushing. Using bushing inserts makes field installation and replacement possible and efficient.

No special tools are necessary. The insert can be installed by hand or with the assistance of a torque tool.

Bushing Insert

Figure 12.

8.1.8.2 Rotatable feedthru insert

The Rotatable Feedthru Insert is used to provide dual bushings from a single apparatus bushing well. It makes converting radial-feed transformers to feedthru transformers and adding in-line arrester protection both easy and practical.

Rotatable Feedthru Insert

Figure13.

8.1.9. Overpressure-relief valve
This element is used to relief transformer internal pressure when it exceeds design limits. This valve does not operate under conditions of sudden over-pressure, as those generated in short circuit presence.

8.1.10. Drainage and sampling accessories
In the superior part on low voltage side, there is a nipple used to connect the filter-press equipment and also connect the equipment for hermetic test.

8.1.11. Tank ground pad
Tank ground pads are metallic pieces welded to the tank to make the connection to physical ground. These pieces should be free of painting and grease to avoid false contacts.

8.1.12. Handhole cover
These are used to have access to the interior tank, and to be able to make inspection and/or maintenance maneuvers. They are protected of the exterior by the tank cover.

8.1.13. Insulated liquid level gauge
Liquid level gauge is an accessory that is used in the transformers with capabilities of 225 kVA and bigger. This device (Fig. 14) has a float that is in direct contact with the insulating liquid, and it allows to know which is the nominal level, minimum level and maximum level allowed in the transformer operation.

The dial is divided in levels:

Under - (MIN)
Nominal - (25°C)
High - (MAX)

Insolating liquid level gauge.

Figure14.

8.1.14. Temperature gauge
It is an accessory that is used in the transformers with capabilities of 225 kVA and bigger. It indicates the oil temperature in the transformer tank superior part. Their graduation is in centigrade degrees (°C), and it has two needles: one indicates the actual temperature in the transformer, the second work as a witness of the maximum temperature reached inside the transformer (Fig. 15).

Insolating liquid temperature gauge.

Figure 15.

8.1.15. Pressure relief device (prd)
Transformers could one this devices located on the main cover . For detail on location, refer to the outline drawing. This device can be installed before oil filling. To assemble the flag remove one of the cover screws and install the flag so it is centered over the operation indicator pin.

CAUTION!
Never make connections that are not authorized by the manufacturer or are not indicated in the Nameplate.

8.1.16. Rapid /sudden pressure rise ralay
Install the relay after vacuum filling process. Once the device is installed the bleed valve should be opened long enough to allow one half pint of oil to flow out.

8.1.17. Screw torque
It should be assured, mainly in the maintenance tasks that the torque used on the transformer screws fulfill that indicated in the Table 1. Fulfill this point will contribute to avoid oil leakages or the entrance of humidity into the transformer.

Note: Most of transformers have a plate in which the Table 1 has been recorded.

Table 1. Recommended torque

SCREW	[Kg-m]
H. V. Bushings flange	0.75 – 1.33
L.V. Bushings flange	2.19 – 2.76
Tap changer fastening	0.80 – 1.38
Expulsión fuse fastening	1.27 – 1.84
Handhole	1.38 – 1.96

8.2. Altitude
To be able to have the pad-mounted transformer nominal capability, in kVA, it is very important at the time of installation to respect the maximum height over the sea level for which was designed, whose reference is shown in the nameplate.

For bigger altitudes the air density decreases, reducing the cooling system efficiency as well as the air dielectric strength.

8.3. Ambient temperature
The limits specified by the standards by which the transformer was manufactured shall not be exceeded (usually -5°C to 40°C).
When an apparatus is operated to an ambient temperature bigger than the limit indicated in the nameplate, the nominal transformer capability will be reduced by each degree centigrade according to the Table 2.

Table 2. Reduction of the Pad-Mounted Transformer capability according to ANSI load guide

TRANSFORMER TYPE	% OF REDUCTION KVA/CENTIGRADE DEGREE
Oil immersed self-cooled ONAN	1,5
Oil immersed air forced ONAF	1,0
Oil forced, air forced OFAF	1,0

8.4. Voltage variation
The transformer can be operated in a continuous way to nominal or smaller capability if the primary voltage is between 0 and 5% smaller to the nominal value.

8.5. Overload
The transformer can be operated with a bigger load than nominal for short periods without suffering damages according to Table 3. It is recommended to refer to the Transformer Loading Guide for mineral oil immersed pad-

mounted distribution transformers greater than 501 kVA, Norm ANSI-C57.92.

9.6. Connections
The connections that are not shown in the nameplate must not be realized.

9. LOAD

The transformers can be operated at full load inside the temperature elevation nominal range without loss of life, taking into account the execution of the following conditions:

1. The ambient temperature is not greater than 40°C or the average more than 30°C in a 24-hours period.
2. The pad-mounted transformer altitude above sea level in operation place shall not exceed the value indicated in the nameplate. Communicate with GE PROLEC representative to operate at bigger altitudes.

The pad-mounted transformers manufactured by GE PRLOLEC can be overloaded for short periods without suffering damages. The allowed overload and the corresponding period of time must be realized according to Table 3, and an ambient temperature reference of 40°C. Table 3 agrees with Norm ANSI C57.92.

Table 3. Overloads allowed for GE PROLEC GE pad-mounted transformers.

Previous load in stable load conditions expressed in % of transformer capability.	Overload duration allowed in % of nominal power.				
	10%	20%	30%	40%	50%
50	3 hr	1.5 hr	1 hr	30 min	15 min
75	2 hr	1 hr	30 min	15 min	8min
90	1 hr	30 hr	15 hr	8 min	4 min

10. APPLICABLE NORMS

The pad-mounted transformers have been developed under the following Norms:

NMX-J-116-ANCE	Overhead - type and substation -type distribution transformers - specifications. Transformadores de distribución tipo poste y tipo subestación – especificaciones.
NMX-J-123-ANCE	ransformers – transformer insulating mineral oils – specifications, sampling and test methods. Transformadores – aceites minerales aislantes para transformadores – especificaciones, muestreo y métodos de prueba.
NMX-J-169-ANCE	Distribution and power transformers and autotransformadores – test methods. Transformadores y autotransformadores de distribución y potencia – métodos de prueba.
NMX-J-285	Single phase and three phase pad-mounted transformers for underground distribution systems – specifications. Transformadores tipo pedestal monofásicos y trifásicos para distribución subterranea – especificaciones.
NMX-J-308-ANCE for	Transformers - handling, storage, control and treatment guide for oils insulating minerals transformers in service. Transformadores - guía para el manejo, almacenamiento, control y tratamiento de aceites minerales aislantes para transformadores en servicio.
NMX-J-404	Separable insulated connector for power distribution system. Conectores aislados separables tipo codo para 15, 25 y 35 kv.
NMX-J-409-ANCE	Transformers – load guide for Distribution and power oil submerged transformers. Transformadores - guía de carga de transformadores de distribución y potencia sumergidos en aceite.
NMX-J-410	Installation and maintenance guide for oil submerged transformers.

11. GUIDES FOR TRANSFORMERS MAINTENANCE

The transformer disconnection of an electric system causes considerable production losses, as well as other inconveniences. For this reason, it is important to assure a transformer operation free of faults, through a maintenance program that is well structured and that it is faithfully carried out.

The periodic inspection helps to detect abnormal transformer conditions and in their parts, before the damages are bigger.

11.1. Security

The inspection works and maintenance will be made carefully in such way that their execution is planned in detail having in mind the security of the human life and the equipment, therefore a series of recommendations is included for the realization of inspection works or maintenance.

The basic rule of security is to disconnect the transformer of all the electric power sources and ground the terminals.

To disconnect the transformer, follow the next instructions:

a) Disconnect the pad-mounted transformer electric circuit from the primary and secondary terminals.

b) Assure that the disconnection mean is in open position. In case of using fuses, the fuses should be retired and placed in a location not easily accessible, in such way that cannot be accidentally reinstalled.

c) Ground the primary and secondary windings using the transformer bushings, with the purpose of discharging any energy that could be stored in the transformer due to the capacitances. These connection cables to ground should be retired until the whole maintenance work concludes.

If it is necessary to work inside the tank, the internal pressure of the tank should be relieved operating the relief valve.

Special care should be had for not to throw or to leave forgotten any tool inside the transformer tank.

Once the work has been finished, it is necessary to make sure that everything is clear before energizing.

11.2. Manhole

To achieve a good maintenance program it is necessary to take the inspections and repairs register carried out to the transformer.

A preventive maintenance system is effective when the following registrations are taken:

a) An equipment log, which can be a card that contains basic transformer information, just as serial number, location, nameplate, etc.

b) A repairs log. It is an essential diagnosis register to eliminate future difficulties.

c) An inspection revision list. It is simply a listing of points that have to be revised, dates and/or frequencies in that will be taken to effect.

Without these logs it will be very difficult that a program of preventive maintenance works, so the inspection knowledge got will get lost quickly.

WARNING
The transformer maintenance operations described in this manual should only be carried out by competent technicians that are familiarized with the pertinent security practices with the handling of dangerous electric equipment. **The instructions contained here are directed to this personal and not substitute the appropriate training and the experience in safe procedures for handling this type of product.** **The maintenance procedures described in this section do not replace the client´s maintenance practices.**

In case that some protection relay has worked and alarm, it is important to investigate the cause of the problem. It is essential to detect which relay has operated and in combination with which protection device made it.

It must be fully investigated, any other abnormal symptom just as excessive level of audible sound, high or low oil level, etc.

11.3. MAINTENANCE PROCEDURES

Being the transformer a static device, it can be subject to operation conditions that exceed those specified as normal conditions. Depending on the duration of the same ones, a decrease of its expectation of useful life can be generated. In this section practical procedures are provided about of how to maintain and give service to the transformer.

PROCEDURE 1		
LOADS VOLTAGES AND CURRENTS	Every three weeks:	• Register each phase operation values.
PROCEDURE 2		
OIL TEMPERATURE GAUGE	Every three weeks:	• Register oil temperatures.
	Yearly:	• Verify gauge temperature calibration. • Verify and clean the gauge.

IMPORTANT NOTE about temperature values interpretation:

The transformer is usually designed to operate continually to 100% of load to a temperature ambient average of 30°C (to above sea level indicated in the nameplate). The winding hottest spot temperature will be, in general, 15°C bigger than the oil temperature.

Example: For a transformer with a 55°C of temperature over-elevation indicated in the nameplate:

T. ambient	= 26°C
T. Oil (nominal load)	= 74°C
T. Honest spot	= 86°C

So it can be inferred that the transformer is operating normally, because the oil temperature is smaller than the permissible of 85°C (30 °C of ambient temperature plus 55°C of oil over-elevation). The hottest spot temperature must not be higher than 105°C, so an 86°C temperature is acceptable.

PROCEDURE 3

Tank and radiators

Every three weeks:

- Revise noises or strange vibrations.
- Revise oil leakages (radiators, inspection registers, instruments, valves, etcetera).

Yearly:

- Clean the heat dissipation surface (adjust the frequency of this activity according to the atmosphere conditions peculiar of the installation place).
- Apply painting where be necessary.
- Tightly screwing all vibration parts according to Table 1.
- Check radiators valves operation.

PROCEDURE 4

Valve and stopper

Every three weeks:

- Inspect all the valves, stopper and oil pipeline.
- If leakages exist, it is important to program an out of service maintance.
- Revise draining valves that can be operated without keys to prevent missoperation.

PROCEDURE 5

Oil level gauge

Every three weeks:

- Check the oil level. Register variations in the oil level, taking into account the level change due to changes in the oil temperature.

Yearly:

- Clean the mask.
- Fill of mineral oil for transformer, in case the level is under the normal level for a 25°C temperature or smaller.

PROCEDURE 6

Insulating liquid

Yearly:

- In order to continuously monitor the transformer and detect and prevent possible failures it must be done at least once a year the next test:
- DGA Dissolved gas analysis (ANSI C57-104)
- Dielectric Strength (ASTM D-1816)
- Water content (ASTM D-1533)
For more information please refer to ANSI C57-106 standard (current version)

13. FAST REFERENCE FOR PROBLEMS SOLUTIONS

PRESENTED PROBLEM / SUGGESTED ACTION	FUSE AND SWITCHES OPERATION	FUSE OPERATION	DIFERENT VOLTAGE BETWEEN PHASES	TRANSFORMER TEST RATIO NO MATCH WITH NAMEPLATE	OIL STAINS IN COVER TANK OR ACCESSORIES
Verify that the surge arrester is not faulty.	X				
Verify that the surge arrester is the correct one.	X				
Verify the correct transformer grounded.			X		
Revise that the ground connection systems are the correct ones.			X		
Revise that the bridge X0 to ground is good connected.			X		
Verify that the tank has a good physical ground.			X		
Verify that the capacitors bank is disconnected.			X		
Revise that all terminals cables are tighten to bushings.			X		
Verify that there is not low voltage.			X		
Check that the cables size is adequate.	X		X		
Verify that the bushing blade are appropriately connected.			X		
Verify that the fuses are not operated.				X	
Verify the fuses capacity.	X	X			
Revise that there are not faults in the primary o secondary system.	X	X			
Check that the motors or starters are good coordinated with protection system.	X	X	X		
Verify that the transformer is not being used for up of their nominal capability.	X	X	X		
Revise that the tap changer is not in different position.				X	
Revise that the tap changer is making good contact.			X	X	
Verify that the load type is not variable.			X		
Revise the primary voltage.			X		
Clean and adjust all the screws according Table 1.					X

A.1. Switches

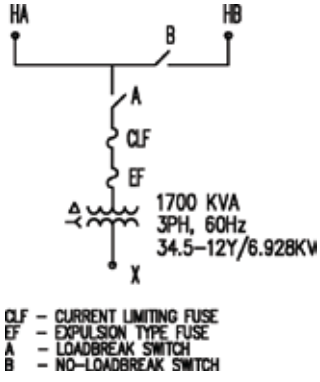
The units are provided with two switches as shown with letters “A” and “B” in Fig 1. Switch A can energize or de-energize the transformer in nominal loading conditions, i.e.. NOTICE the switch A shall not be operated in short-circuit conditions. Switch B is connected on HB terminal side of transformer. Due to current carried by switch B and nominal operating voltage. NOTICE The switch B shall not be operated with load, so before operating it the electrical loop circuit at which it is connected shall be de-energize.

WARNING
Switch B shall not be operated with load. Failure to comply will result in serious personal injury, death, or damage to the equipment.

A.2. Oil Submersible Protector

The Oil Submersible Protector (OSP) is a partial-range current-limiting fuse that is designed to clear internal failures in the transformer, and its protection is coordinated with expulsion fuses. Current-limiting fuses are located under oil beneath the transformer handhold (see Photos 1 and 2).

DANGER
Before attempting to remove internal fuses de-energize the transformer. Qualified personnel must perform installation or replacement of fuses.



Schematic of 1700KVA transformer.

Figure. A.1

For better information consult manufacturer´s technical datasheets.

DANGER
De-energize the transformer before attempting to remove internal fuses. Failure to comply may result in severe personal injury or death.

A.3. Expulsion fuses

Expulsion fuses protect the transformer against severe overloads and low intensity short circuits. These fuses are located under oil beneath the transformer handhold (see Photos 1 and 2).

DANGER
Before attempting to remove internal fuses de-energize the transformer. Failure to comply will result in severe personal injury or death. Qualified personnel must perform installation or replacement of fuses.

View of handhole installed on transformer tank cover.

Photo 1.

View of tank inside through the handhold.

Photo 2.

A.4. Lock

LV compartment door has been set up for the installation of a lock, whose function is to prevent from turning the door handle and getting access to the LV compartment.

The next components are required to install the lock. PROLEC GE provides one set for each transformer.

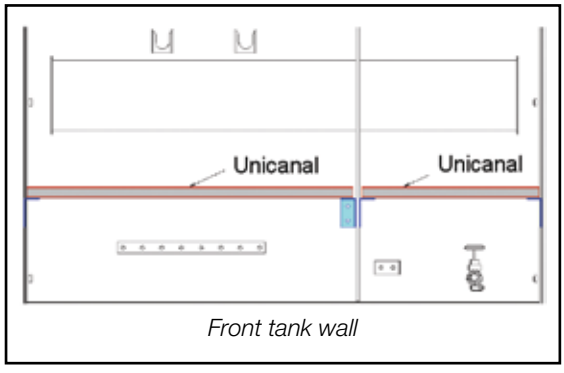
1. Kirk Key type F lock; 1 piece.
2. Mechanical Nylamid base support, 1 piece.
3. Security bolts (truss head) 3/8”-16 x 3”; 2 pieces.
4. Plain washers, 3/8”; 2 pieces.
5. Nuts, 3/8”; 2 pieces.
6. Lock washers, 3/8”, 2 pieces.

Tools required are:

1. Truss spanner screwdriver #14 (PROLEC GE provides 6 screwdrivers in total)
2. 9/16” socket wrench (Prolec GE does not provide this tool).

A.5. Cushion clamps installation

Unistrut channels (1 5/8” X 1 5/8”) have been added to transformer cabinets, one in HV side and one in LV side, which support cushion clamps that hold cables connected to HV and LV bushings. See Figs. 2 and 3.



Front tank wall

Figure. A.2

Clamps should be installed on-site after cables have been connected to the transformer bushings. According to client's instructions, Prolec GE provides cushion clamps in four sizes: 1 3/8", 1 7/8", 2 1/8", and 2 3/8", corresponding to diameters of cable gauges 4/0 for 15 kV class and 250, 500 and 800 for 35 kV class, respectively, every cable with 133% insulation.

First, place cushions around each cable; they can be easily spread out by hand and fit to the shape of the conductor. Next place the metallic clamps in the Unistrut channel, one at each side of the cushion: slide them along the channel and fit them around the cushion. Finally screw the nut tightly on the bolt so the conductor is firmly held by the clamp. See Fig 3. Repeat this procedure for every cable connected to the transformer (nine in total).

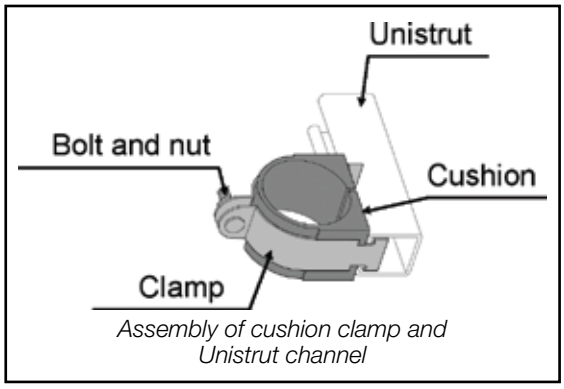


Figure. A.3

Three 13/8" cushion clamps shall be installed on LV side Unistrut channel and six clamps of a different size on the HV side Unistrut channel; this size depends on the gauge of the cable used by the client (it will vary from one transformer to other).

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