

Raychem RPG

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OPERATION & MAINTENANCE MANUAL FOR TRANSFORMERS



Raychem RPG (P) Ltd.
Gat No.426/2B, Chakan - Talegaon Road,
Mahalunge Village, Talk - Khed, Dist. Pune 410501

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DISCLAIMER & WARNING:

- Liability of Raychem RPG (P) Ltd. Is only limited to the product supplied (transformers).
- Failure to observe safety precautions, Electricity rules and unauthorized operation or operation by untrained people may result in death or serious Injury. Our liability does not cover such damage and also any created consequential damage/loss. Our liability is only for product and that too during guarantees/ warranty period.
- During rectification period any liability for hiring/production loss etc. are not in Raychem RPG scope.
- Our liability does not cover any production loss or any expenses incurred by customer for hiring/buying any equipment or apparatus or any consequential expenses during repair/rectification period.
- Due to constant improvement in the product, Raychem RPG Pvt. Ltd. reserves the right to change specification and details mentioned in the Manual, for detailed information or specific queries please contact the manufacturer.

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1.0 INTRODUCTION:

1.01 GENERAL:

- RRPL make transformers are designed, manufactured and tested to high standard of practice and are reputed for their quality and reliability in service. With proper installation, commissioning, protection and timely maintenance during operation, the users shall definitely receive a high quality standard service.

- The purpose of this Instruction Manual is to provide guidance on the installation, commissioning and maintenance of Oil Filled transformers. This guide is necessarily general in nature. In the event of any doubt, query arises or need for any further information or any irregularity / deviation from IEC / BS / IS / Equivalent Standard, observed, please refer to the manufacturer for clarification and possible assistance.

- The transformer along with all its accessories / fittings should be installed, commissioned, operated and maintained under the supervision of a competent electrical engineer in accordance with relevant statutory requirements and good engineering practices, including Code of Practice, where applicable, and properly used within the terms of specification.

- For the Domestic/International Standards & Codes of Practice, reference should also be made to the current edition / publication of IEC / IS / Equivalent standards. A list of Standards & Codes of Practice for selection, construction, application & operation of various transformers will be furnished on request.

- All products have been designed, tested and supplied as per the specification and standards quoted, order acknowledged and subsequent modification as approved.

- Some accessories / fittings / components referred in this manual are supplied only when specified and may not be incorporated into all the transformers supplied. The equipment supplied may differ in minor details from the data given herein.

- For information about the transformer actually supplied, ALWAYS refer to the Drawings, Technical Specification Sheet, Manufacturer's Instruction / Product Catalogue of the Accessories / Fittings and such documents furnished with the hand-over documents.

- Transformer tank is suitably designed to allow the safe lifting & transportation of the complete unit without over-straining the joints / clamps that are supporting the core & winding assembly, radiators, etc. and effectively sealed for any oil leakage. In case of cover mounted jobs, complete job to be lifted from lugs provided on top cover, the tank lifting may be suitable for lifting only tank without CCA.

- All floor mounted transformers are provided with skid type under-base with pulling eyes or axle holes suitable for handling with roller bars. Wherever required, foundation / mounting holes are provided in the under-base.

- A Marshaling Box is provided to marshal all the transformer auxiliary wiring for convenience of external connection.

- In addition to the standard Fittings / Accessories, the other optional / additional items as required by customer's specification are provided. All the items are listed in the Approved Drawing furnished with the handing-over documents.

- Normal construction consists of three limb magnetic core assembly, with each phase comprising of separate HV and LV Coils properly insulated, suitably supported and clamped. The whole assembly / structure is totally immersed in an oil-filled, fabricated tank.

1.02 CAUTION:

- No transformer should have rated service voltage applied to it until ALL preliminary work (Clause No. 3) and pre-commissioning tests (Clause No. 4.02) and checks have been satisfactorily completed.
- A transformer which has been removed /stored from service for a long period of time should be rechecked prior to re-energizing and placing the transformer back into service.
- Once the commissioning checks are completed, the transformer should be energized as early as possible. Avoid delays leading to changes in atmospheric temperature by 5~7 Deg. C. Else certain checks/activities such as air release etc. need to be repeated. As such whole commissioning exercise needs to be repeated.
- No high voltage tests should be applied to any transformer without making reference to the manufacturer.
- For an anticipated variation appearing in the supply voltage, the secondary side supply voltage is maintained within prescribed limits by the use of an Off-Circuit Tap Changer (OCTC) mounted integrally within the transformer or On Load Tap Changer (OLTC), whichever is provided.



The OCTC should be changed/operated ONLY when the transformer is 'Off-Circuit' i.e. totally isolated from the power supply, otherwise this can lead to severe accident causing heavy arcing at tap connections which may cause a fire / explosion hazard.

1.03 HEALTH AND SAFETY:

- Materials or components that are liable to be exposed or handled in normal operation & maintenance and which present any hazard to health are covered here under.
- During design of an electrical distribution system including a transformer, care shall be taken with the following aspects;
 - a) Selection of transformer installation site having adequate ventilation, normal operating temperature, protection against fire, moisture, explosion, etc.
 - b) Selection of electrical protection at both primary & secondary side against over-load, short-circuit, earth-fault, etc.
 - c) Provision for regular inspection & maintenance.
 - In addition to the instruction given in this manual, IS / BS / IEC / equivalent standards and local regulation should also be referred for other details regarding the design, materials and performance.
 - Excessive and prolonged skin contact with transformer oil (mineral oil) should be avoided.

1.04 MAJOR APPLICABLE STANDARDS:

- IS 2026, IEC 60076 & BS 171, ANSI C 57, AS 2374

1.05 STANDARD FITTINGS:

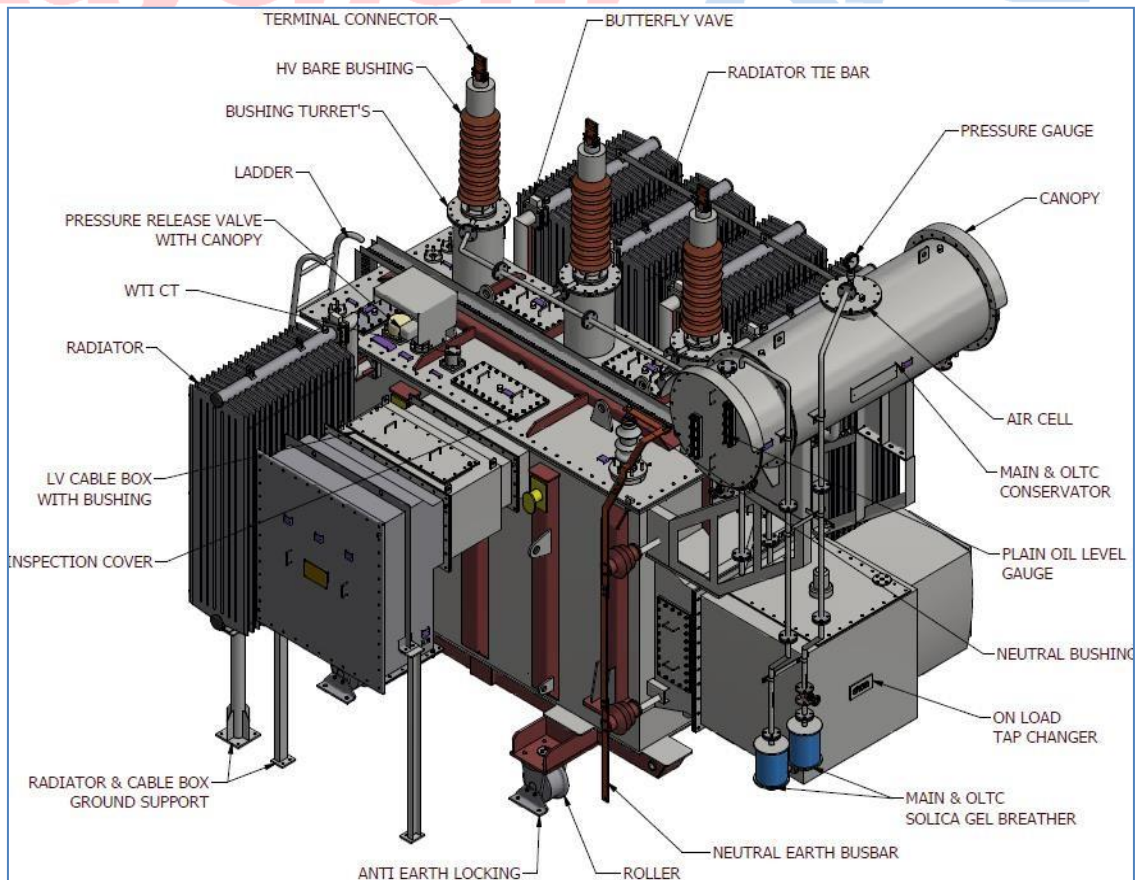
As per IS / BS / IEC standards the 'Standard Fittings' as listed below, are the minimum requirements for the safe & correct operation of a transformer.

- a) Diagram & Rating Plate
- b) Off-Circuit Tapping Switch /On Load Tap Changer (when required)
- c) Oil Level Indicator
- d) Oil Drain Valve
- e) Bushings: (i) Porcelain/Epoxy Bushings or (ii) Plug-in Bushings (as per requirement)
- f) Earthing Terminals
- g) Lifting Lugs
- h) Jacking Pad
- i) Thermometer Pocket
- j) Breather Pipe with Dehydrating Breather.
- k) Conservator as specified by customer specification.

1.06 OPTIONAL FITTINGS:

The Optional Fittings as listed below are provided as per customer specifications.

- a) Oil Temperature Indicator & Winding Temperature Indicator with WTI CT
- b) Buchholz Relay
- c) Pressure Relief Valve
- d) Disconnecting Chamber
- f) Oil Filter Valve
- g) Rollers
- h) Marshaling box for all wiring
- i) HV & LV Cable Box, Bus duct.



2 TRANSPORT, RECEIPT, HANDLING & STORAGE:

2.01 ARRANGEMENT FOR TRANSPORTATION:



- Each transformer is dispatched in clean & dry condition from Factory.
- Due to transport limitation and for convenience of storage/handling at site, in most of the cases a transformer cannot be dispatched completely assembled hence the transformer is usually dispatched from the factory with oil covering the core & winding along with the balance oil in separate sealed drums.
 - Parts that are liable to be damaged in transit are detached and dispatched in separate cases along with the transformer. Accessories like radiators, bushings (for higher rating), dehydrating breathers, buchholz relays, conservator, cable boxes, rollers, support insulators etc., are usually detached before dispatch.
 - Weatherproof blanking (red color) plate and gaskets are provided where necessary.
 - The parts removed for transport are generally indicated in Packing List furnished along with the unit during delivery / handing-over of the equipment.
 - Re-assembly of these parts should be carried in controlled environmental conditions (Free from dust, water droplets, rain etc.) to avoid ingress of moisture in transformer.

2.02 RECOMMENDED INSPECTION:

- Transformers are properly packed & dispatched by suitable transport up to destination. All consignment should be checked thoroughly after receipt at site. Post inspection; the transformer should be packed in the similar fashion to avoid ingress of water/dust.
 - Immediately on arrival at site, transformer should be examined for any physical damage in transit with particular attention to;
 - 1) Dents / cracks in tank side-walls, covers, radiators, etc.
 - 2) Damage to protruding fitting such as bushings, valves, sight glasses etc.
 - 3) Damages to external packing.
 - 4) Loose bolts / screws / clamps.
 - 5) Oil leakage, particularly along welded joints & gaskets.
 - 6) Oil level in main tank.
 - 7) Intactness of seals provided on all possible oil outlets (as per the picture).

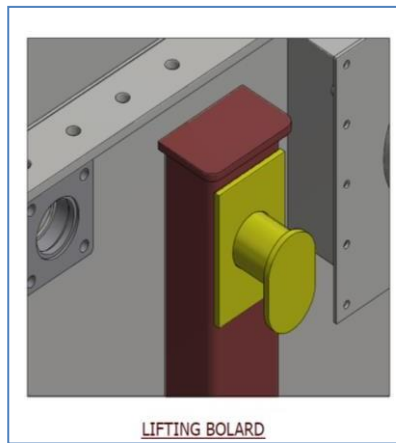
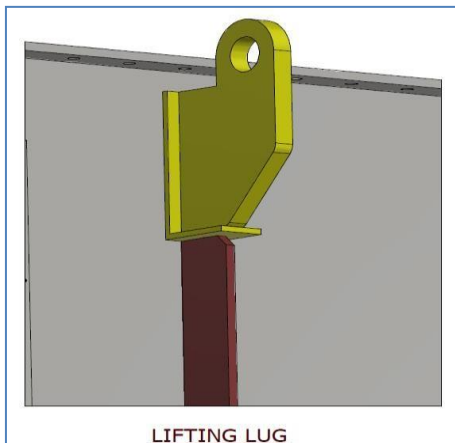


! SHORTAGE/ DAMAGE TO BE IMMEDIATELY REPORTED WITHIN ONE DAY OF TRANSFORMER RECEIPT

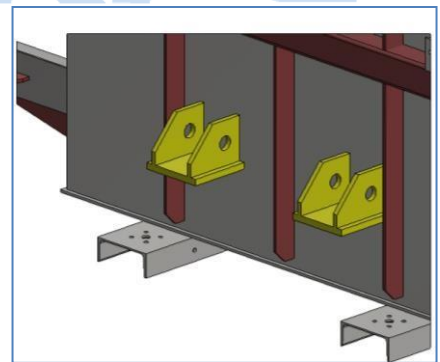
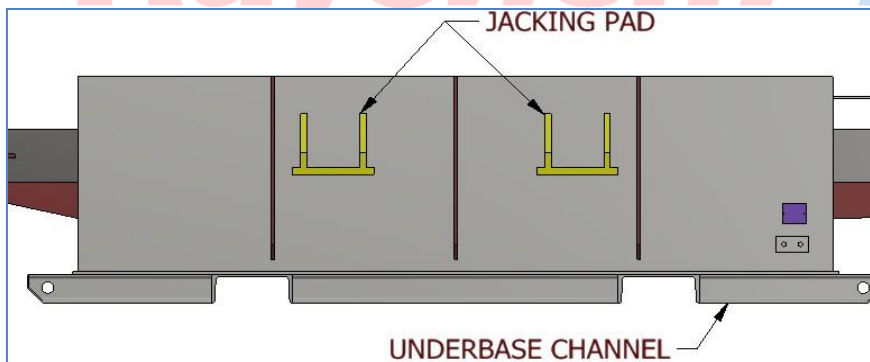
- Unless there is reason to suspect internal damage, the tank cover should not be opened and no attempt to lift Core & Coils Assembly from the tank should be made. Internal inspection should be carried out to the maximum possible extent only via inspection covers provided. (Not applicable for Hermetically Sealed Type).

2.03 UNLOADING & HANDLING OF TRANSFORMER AT SITE:

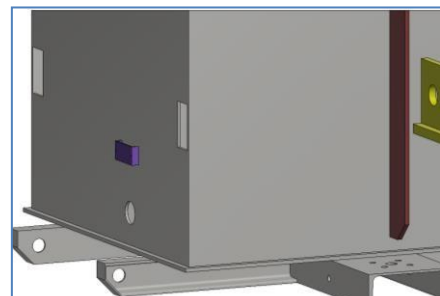
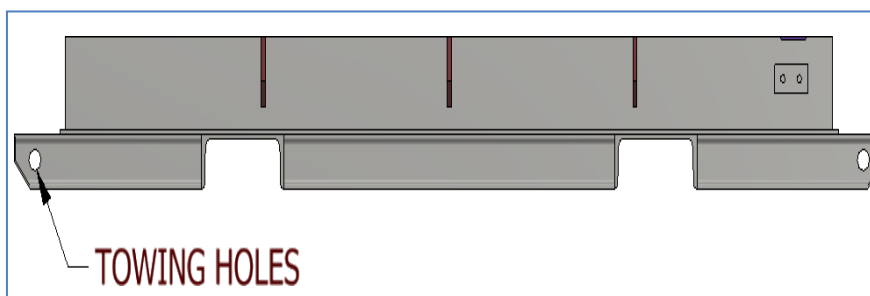
- The transformer should be unloaded by means of crane or suitable lifting device of sufficient capacity (For weight details, please refer the Rating & Diagram Plate). Always use lifting mechanisms, crane, chain pulleys, etc. of adequate capacity. Use of any under capacity lifting mechanism or accessories could result in severe damage to the transformer, lifting equipment and possibly personnel involved in handling the transformer.
- For lifting transformer, suitable lugs are provided on the sides of tank. Lifting lugs/bollards on the sides of tank are for lifting the complete unit, whereas the lugs provided on the tank cover must only be used for lifting the top cover.



- Jacking pads are provided to lift the transformer with jacks. Jacks should NEVER be placed under any valves or radiators. Do not use low capacity lifting jacks.



- Skid type under base channels are provided on the bottom of the transformer, having towing holes for pulling & mounting holes for foundation of transformer. For heavy transformers, the under base is equipped with rollers allowing the unit to be moved into final position and then anchored.



2.04 STORAGE:

- Accessories / Fittings dispatched separately from main consignment are usually packed in boxes/crate, although certain items like conservator are sometimes dispatched with wooden base. All items as received should be stored in a dry and covered place provided there are no signs of damage or rough handling.

- If oil received in drums is not to be used immediately, the drums should be stored in a covered space where the temperature variation is minimum. If it is necessary to store the oil outside, adequate protection must be provided at all times. Drums should not stand on end but should be placed on their sides in horizontal (lying) position.

- After arrival at site, it is desirable to erect and commission the transformer with minimum delay. In case this is not possible, the transformer should be fitted with conservator, dehydrating breather, etc. and filled with oil. The condition of silica gel must be checked periodically, particularly during warm and wet periods.

- Indoor type transformer must be protected from the weather. Outdoor units may be stored outside, in a warm area, if possible, protected from the prevailing weather.

- Heaters for marshaling box, cable box, etc., should preferably be kept energized to avoid possible internal condensation / deterioration of the internal components.

- It is recommended that as much of the original manufacturing packaging should be kept in place as possible during storage.



CARE SHOULD BE TAKEN WHILE UNPACKING OF THE ACCESSORIES FROM THE WOODEN BOXES TO AVOID DAMAGE

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3 INSTALLATION:

The Electrical installation compiles with the following points:

- a) The latest Indian Electricity Act.
- b) Local utility rules & regulations.
- c) IEC60076-11 -2018, Annex A
- d) IS 10028: Code of practice for Selection, Installation & Maintenance of Transformer.
- e) The electrical installation should be carried out by authorized persons competent to undertake such work.

3.01 PRECAUTIONS:

- All accessories / fittings / components dispatched separately should be thoroughly cleaned inside and outside before being fitted. Same should be fixed in their respective places according to the relevant drawings. If rusting observed in any part of the transformer, same to be cleaned and touch up paint should be applied.
- Workmen accessing the interior of a transformer tank should empty their pockets of all loose articles. Any spanners or other tools used should be securely tied with a tape / thread and attached at tank top, so that they can be recovered, if accidentally dropped into the tank especially for higher capacity voltage ratings of transformers.
- Fibrous cleaning materials MUST not be used. The presence of loose fiber suspension, in insulating oil, can reduce its insulating properties. If any cleaning or wiping is necessary this must be done with clean and dry soft non-fluffy cloth only.
- Insulating oil is inflammable and under certain circumstances in a confined space, may become explosive.
- Air drawn into the transformer through semi-tight joints or along with the oil may be drawn into the windings thus reducing the insulation. To prevent this, all joints / covers in any extended oil pipe work must be air tight to the required value of torque as defined.
- Under normal circumstances, it is NOT necessary to access the internal parts of the tank. Also, all the required tools / tackles / instruments are generally not available at site for the proper handling access.

3.02 LOCATION AND SITE PREPARATION:

- It is recommended to install a transformer over a leveled floor base of sufficient strength to support the weight of transformer and prevent accumulation of water.
- A foundation including special oil drainage/rain water collection facilities is strongly recommended for large transformers.
- The transformer should be positioned on the foundation such that it is possible to have an easy access to the rating & diagram plate, OCTC, OLTC, thermometers, valves, oil gauges, Marshaling Box etc., to be easily reached, read & operated when required.
- Adequate electrical clearances are to be provided from exposed live parts of the transformer to any earth point. (Ref.: Statutory & Regulatory Requirement on Electrical Clearance in Air)
- Any transformer should always be separated from other transformer, reactors and any other such heat generating equipment. Transformer should be well placed sufficiently away from all walls / partitions to permit free circulation of air / ventilation all around and also for movement of Maintenance personnel.
- Rollers, if fitted, shall be suitably clamped / locked to prevent any movement of transformer from its designated position in relation with HV / LV Side terminations.
- External power conductors, power cables, control cables, earthing conductors, etc., shall be so positioned / supported such that no pressure is exerted on the transformer bushing terminals / cable box.
- Naturally cooled transformers depend entirely upon the circulation of air to dissipate all heat generated due to internal losses. For indoor installation, therefore, the room must be well ventilated so that

heated air can escape and be replaced by fresh cool air. Air inlets/outlets should be sufficient to allow adequate air to cool the unit. The inlets shall be near the floor and outlets shall be near the ceiling. If necessary, exhaust fans can be installed to assist the process.

- If rollers are not fitted, a level concrete plinth with bearing plates / mounting channels of sufficient size/strength can be used for outdoor transformers. To prevent rust formation, it is essential to avoid water accumulation between plinth and the transformer base.
- For small capacity pole mounted type transformer, proper care must be taken that all the supporting poles / structures, mounting brackets / clamps are of suitable materials & strength to bear both the static & dynamic weight of the transformer.
- Suitable provision shall be made for all non-current carrying metal parts used for the transformer support / base such that they can be earthed, preferably at two points.

3.03 INSULATING OIL FILLING:

- Oil acts both, as insulant & as coolant. Cooling radiators fitted with the tank will be either fixed type or detachable type for ONAN (Oil Natural Air Natural) cooling.
- Only the insulating oil supplied along with the transformer shall be used for filling-up or topping-up the transformers.



THE MIXING OF OILS OF DIFFERENT GRADE/STANDARD IS NOT RECOMMENDED

- Oil from different sources may not completely mix together and might remain separated in layers. There may be a greater tendency to form acidity or sludge in a mixture of oil from two different sources than in a mixture of oils from a single source.
- Oil supplied with the transformer is a pure hydro-carbon mineral oil conforming to relevant IS / IEC / BS standards for insulating oil. When exposed, oil is easily prone to get contaminated. It is very important to keep the oil free from contamination, moisture, etc. All equipment's / apparatus to be used for handling the oil should be first cleaned and flushed with clean insulating oil. Particular attention must be paid to cleanliness of bungs / plugs / stopper, valves and other such places, where dirt or moisture tends to get collected.



CONTAMINATED / USED OIL MUST BE DISPOSED ONLY IN ACCORDANCE WITH THE ENVIRONMENTAL REGULATIONS

- Before putting the oil into the tank, it should be tested and comply with specification as per relevant IS / IEC / BS. If the oil does not meet the requirements, it should be processed and should be used ONLY when it meets the specification.
- When filling it is preferable to pump the oil into the bottom of the tank and that an oil drying / filtering device is interposed between the oil pump and the tank reducing to a minimum air entry into the tank along with oil.
- Used oils should NEVER be mixed with the fresh oil.
- Oil should be filled up to the marked level, indicated on the oil level gauge corresponding to the oil temperature at that time.
- Release air from air release plugs of Main Tank, Inspection covers, Radiator, Conservator, Buchholz Relay and its pipe line, Bushing and its turrets. (Air release sequence should start from the bottom most point going upwards covering all air release plugs provided).

- Oil should be allowed to settle allowed to settle, before commissioning / energizing the transformer as per the following table,

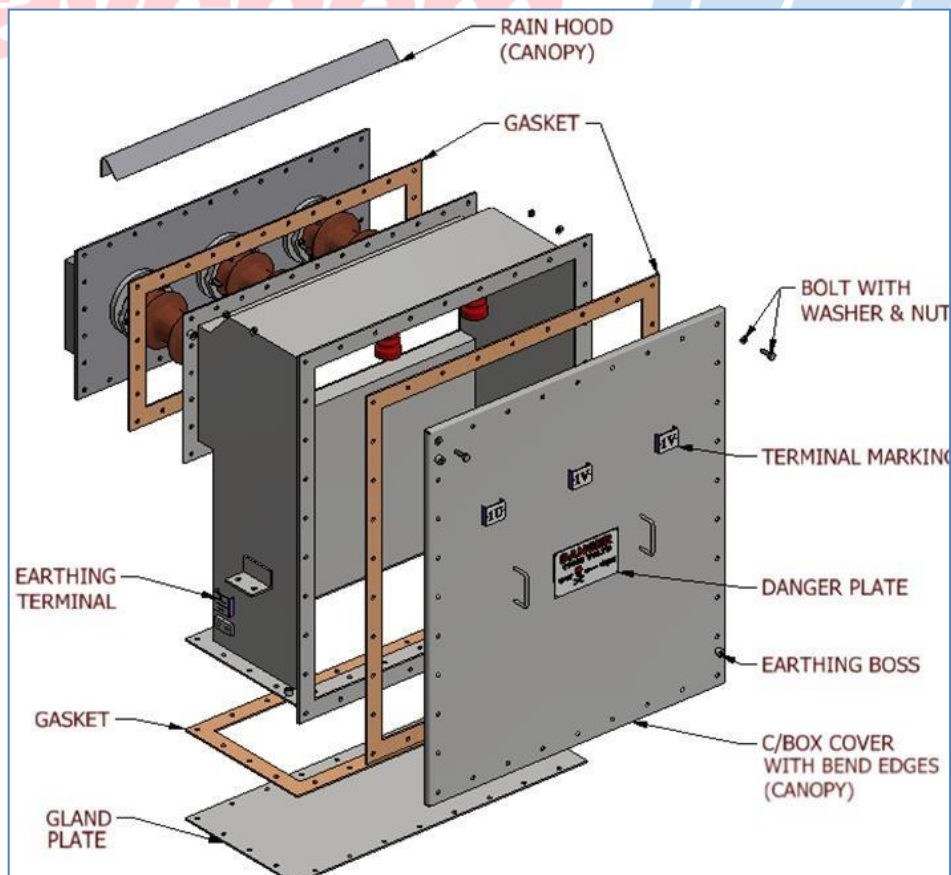
Sr. No.	kV Class of Transformer	Settling Time after Oil Filtration (In Hrs.) if Oil quantity is:	
		up to 3 kl	above 3 kl
1	3.6 – 11	4	8
2	22 – 33	6	12
3	Above 33 – 145	12	18

3.04 GASKETS AND JOINTS:

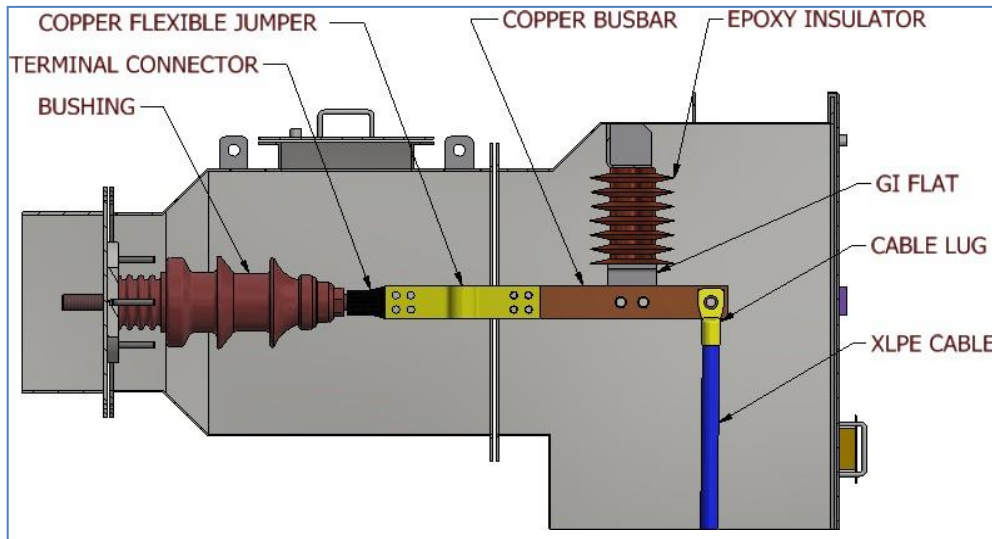
- Transformer sealing gaskets are made of neoprene bonded or rubberized cork. Usually commissioning gasket set is sent loose in pieces cut to size and shape as straight, angled, circular or rectangular whichever is applicable.
- When assembling / joining individual pieces use scarf joints only. Assembled portion should be located away from corners and bolt holes, and should be evenly bonded.
- Gaskets should be best stored in hermetically sealed containers in a cool place. They must be protected from damp, oil and grease.

3.05 CABLE BOXES (IF APPLICABLE/SUPPLIED):

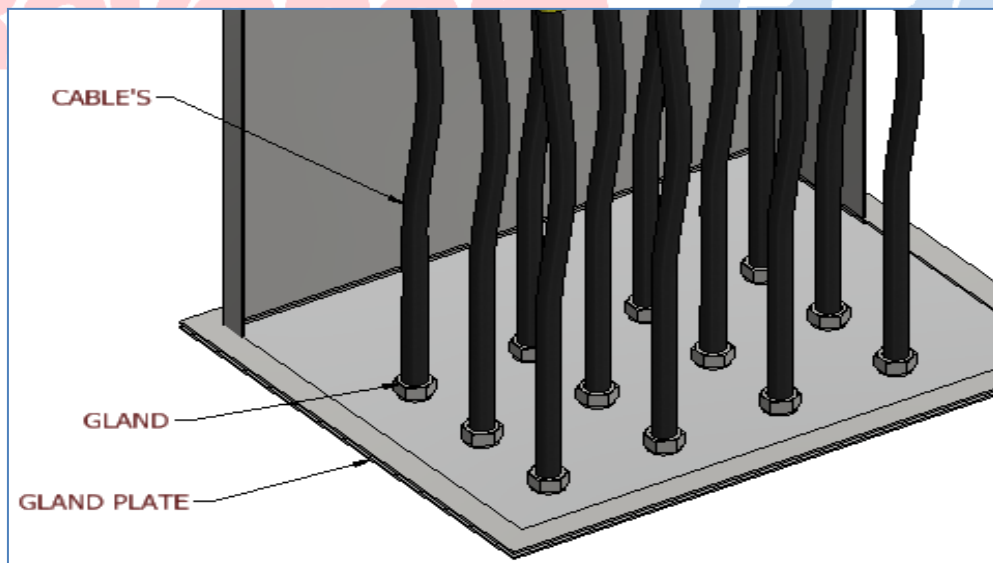
- Cable boxes are usually supplied in separate packages; those should be first fixed on the tank with the proper gasket joints.



- Necessary identification of phases is provided over the cable box door for easy identification.
- The cables should be supported separately to ensure that no-undue strain is exerted on the bushing terminals in the cable box.
- Cables shall be terminated on bus-bars provided in a cable box and termination shall not exceed the number of holes provided. In other words NO extra holes may be made in bus-bar at site.

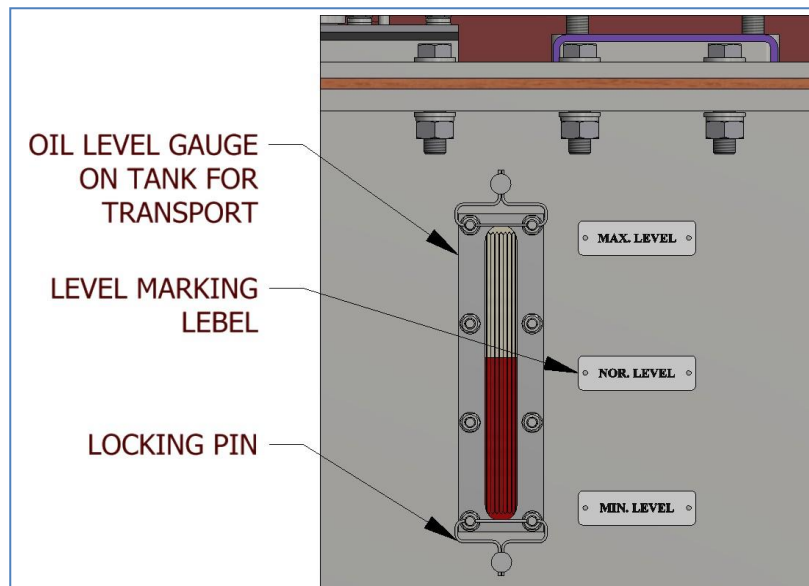
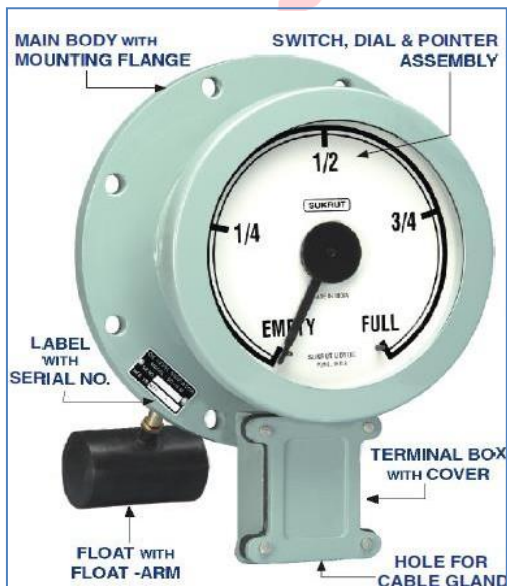
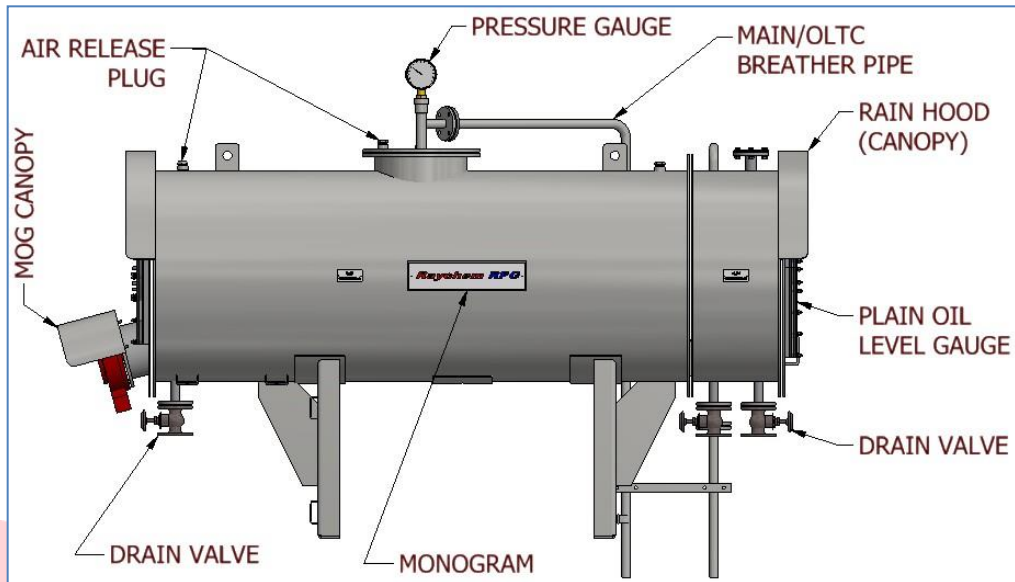


- The cable shall be clamped / supported by suitable cable glands. Care shall be taken to ensure minimal stress on the bus-bar.



3.06 CONSERVATOR (If SUPPLIED):

- Sling with sufficient length & capacity should be used for lifting the conservator while assembling the same with the main unit while installation.
- Slings should be clamped with the lifting hooks provided on the conservator for lifting.
- While assembling the conservator, ensure that internal surface, all openings, pipe works, valves, etc., are clean & free from moisture and all gasket joints are oil-tight.
- Prismatic type oil gauge & Magnetic Oil level Gauge fitted with the conservator, is generally marked with calibrated level to show cold oil level at 30°C temperature.



3.07 DEHYDRATING BREATHER:

- A Dehydrating Breather should be fitted to ensure that air entering the conservator/air cell during breathing is dry thus preventing insulation loss of oil due to internal condensation.
- A Dehydrating Breather filled with Orange Gel (Environed) or Blue gel (Silica gel) is disconnected from transformer and packed separately as loose item.
- In case of Envirogel, for visual indication of degree of saturation, the silica-gel is impregnated with suitable non-toxic dye. Envirogel in YELLOW / ORANGE color, indicates the ACTIVE state or readiness to absorb moisture and when in GREEN color, indicates the INACTIVE / saturated state or presence of moisture or inefficient to absorb further moisture.
- In case of Blue Silica-Gel, for visual indication of degree of saturation, the silica-gel is impregnated with Cobalt Chloride. When Silica-Gel is in BLUE color, this indicates the ACTIVE state or readiness to absorb moisture and when it has become PINK it's unable to absorb further moisture.
- To activate the saturated silica gel, heat it in a pan / oven at 120- 130°C temperature until the original color is regained within 2 to 3 hours, otherwise always replace with new gel and discard the used gel.
- When the oil-filled transformer is fitted with the de-hydrating breather ALWAYS reactivate / replace the desiccant once the color indicates the saturated state, even if the transformer is in de-energized state or in storage.
- The plug sealing the top of the breather should be removed and connected to the associated pipe-work. The oil cap at the bottom of the breather should be removed, filled with insulating oil up to the mark and the cap replaced. The oil seal ensures that breather does not absorb moisture when the transformer is not breathing.



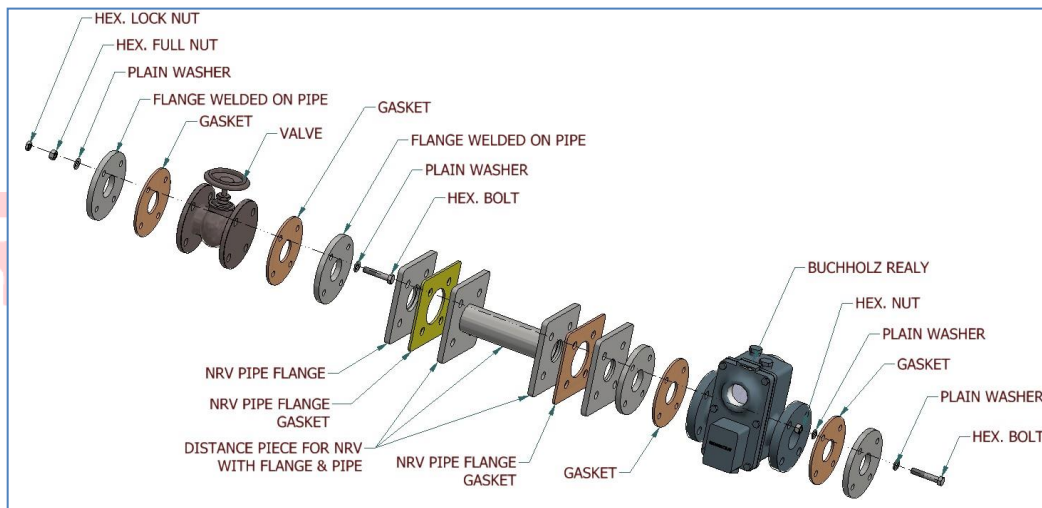
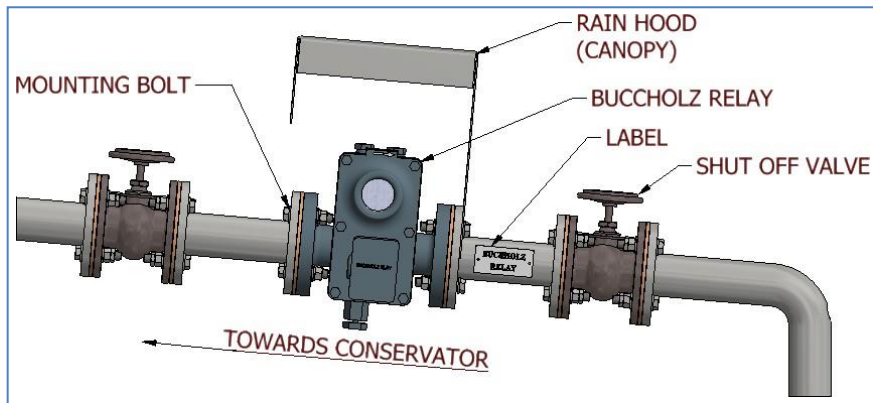
- When refilling the desiccant, do not expose the same to the atmosphere for an undue higher duration of time, otherwise it will start absorbing the moisture and thus impair its purpose. Also, after fixing the breather, ensure oil seal is filled with oil up to the mark.

3.08 PRESSURE RELIEF VALVE:

- A spring loaded device (Pressure Relief Valve) is supplied fitted over the tank. This is fitted with a mechanical indicator for visual indication to show operation.
- A single set of contacts is provided for trip signal. These terminals are clearly marked for function and polarity (locked during shipment), which should be set at service position before energizing the transformer. When checking connection from these terminals in conduits during maintenance, ensure that no condensation can drain into the terminal box.
- Many a times PRV with down comer pipe is provided for allowing the oil spillage (post PRV operation) through the pipe.

3.09 BUCHHOLZ RELAY:

- The buchholz (gas / liquid operated) relay is connected in the pipe work between transformer tank and conservator. If a valve is fitted to isolate the conservator, the buchholz relay is usually on the transformer tank side of the valve.



- Under normal condition the relay is full of oil. As generally known, most types of faults occurring within oil filled transformers are accompanied by the generation of gas in the oil due to liberation of heat. Such generated gas gets accumulated in the relay thereby operating the float / flap switches.

- With an incipient fault, gas is produced at a very slow rate and the upper float (alarm) switch will operate after a specified volume of gas has collected. The upper float (alarm) switch will also indicate the low oil level of the conservator.

- When a major fault occurs, the gas is produced rapidly resulting in sudden surge of oil up to the conservator thereby operating the lower float (trip) switch. The lower float (trip) switch will also indicate the drained oil level of the conservator.

- To ensure correct operation of the relay, the pipe work on either side of the relay and the relay itself, are all set at the same angle (2° - 5° to the horizontal for single float relay and 3° - 7° to the horizontal for double float relay).

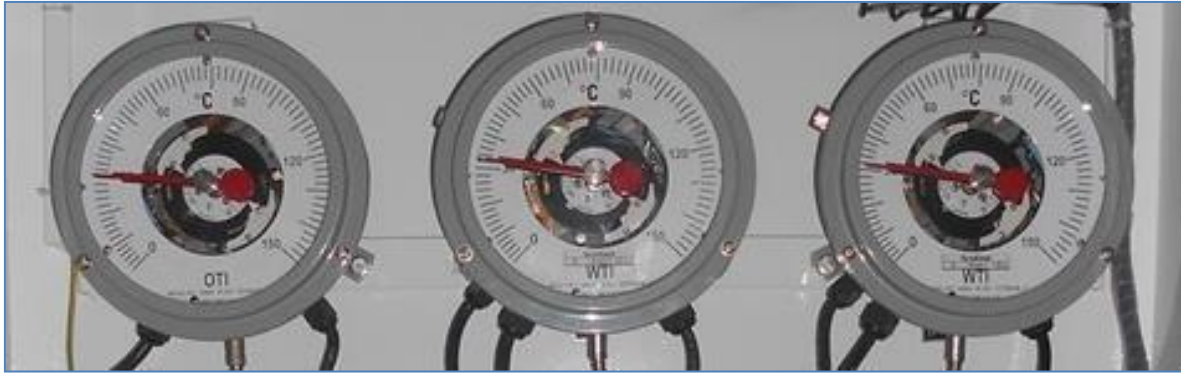
- The arrow shown on the relay should point towards the conservator.

- The alarm and trip terminals are clearly marked for function and polarity (locked during shipment), which should be set at service position before energizing the transformer. After which check that the operating floats / flaps are free. When checking connection from these terminals in conduits during maintenance, ensure that no condensation can drain into the terminal box.

- Flexible pipe along with pet cock is fixed with the buchholz relay for the purpose of gas sampling.
- In service, the top petcock (if supplied) should be kept closed. Before energizing the transformer, all air which may have collected in the relay should be released through the petcock.

3.10 TEMPERATURE INDICATORS (IF SUPPLIED):

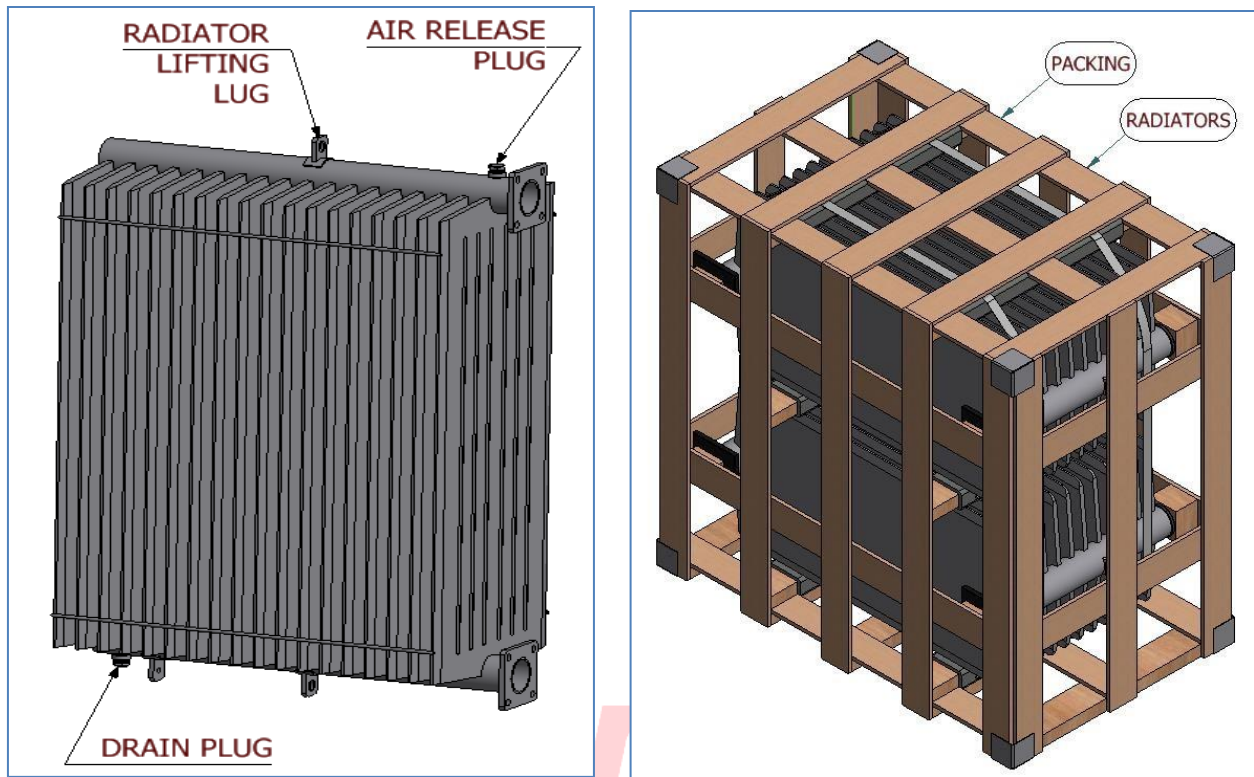
- The Oil Temperature Indicator (OTI) and Winding Temperature Indicator (WTI) provide indication of top oil and hot spot temperature via dial type indicators. In all cases, the indicators shall be mounted vertically for best accuracy of readings.



- The thermometer bulb / probe are connected by capillary tube to the indicator. The bulb / probe shall be fitted into the thermometer pocket provided in the transformer main tank cover near the hottest oil region. Before fitting the bulb / probe, thermometer pockets should be part filled with transformer oil.
- WTI is same as OTI except for the current feed circuit from CT to heating element either on the thermometer pocket or in the instrument itself.
- Normally the current feed to WTI is provided from a CT at one phase of the LV winding. Such CT has suitable Ratio to feed required current to heat the heating element. This additional temperature component from heating element together with the prevailing top oil temperature gives the hot spot temperature seen at WTI. The CT connection to WTI shall be made carefully (Ensure that CT secondary is not open circuit at any time).
- The copper capillary tube is protected by flexible steel tubing, which is strong enough to withstand normal handling. It should NOT, however, be bent sharply or be twisted. To prevent sagging, tube shall be supported by clip along its entire length. And the excess length, if any, can be rolled spirally and on no account it should be cut.
- OTI and WTI are provided with a re-settable maximum pointer and magnetic switches (suitable for earthquakes) for electrical alarm & trip indication, as specified by the customer.
- Before installing the instruments, the accuracy can be checked by dipping the bulb/ probe in a hot oil or water bath and checking the instrument readings against a standard calibrated thermometer. The indicator readings should be allowed to steady (inherent time lag) and the readings shall be accurate **within 1°C or the within the tolerance specified.**
- The alarm & trip setting for OTI & WTI are mentioned in the Marshalling box wiring drawing supplied along with the transformer.
- If required, alarm / trip switches shall be adjusted to make contact at the set temperatures as per site conditions i.e. ambient temperature, loading conditions, etc.

3.11 COOLING RADIATOR:

- Detachable radiators are packed separately and shipped. All the radiators, pipe work and headers should be cleaned and flushed with clean dry oil before fitting. These should be assembled as shown on the Outline/G.A drawing.



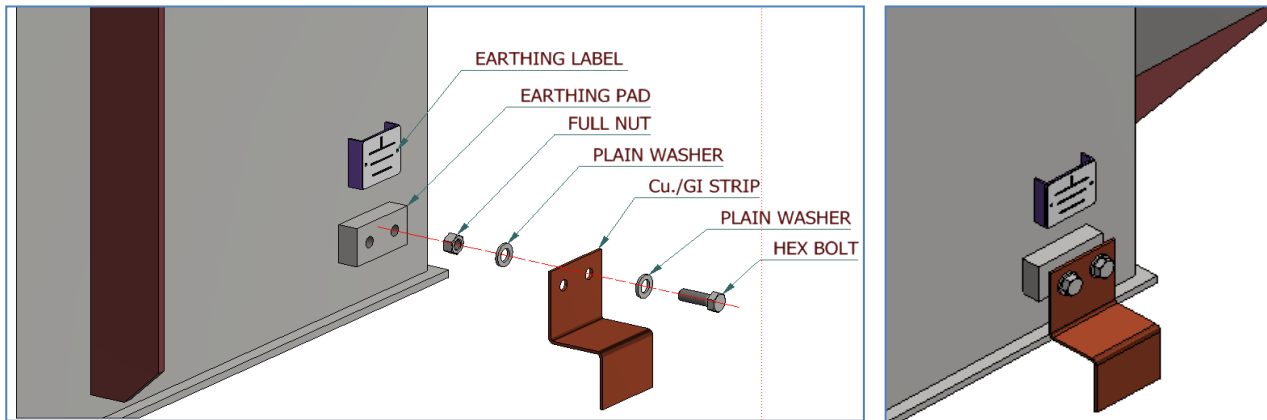
- The gaskets between the butterfly valve and blanking plate fitted by the manufacturer should be replaced with the fresh set of commissioning gasket provided in loose accessories box.
- Ensure even fitment of gaskets.
- During assembly care must be taken that all the gasket joints between radiator and the transformer tank are air-tight and the flanges are evenly fitted.
- Ensure tightness of drain plugs available at the bottom portion of the radiator.
- After assembly of radiators, the shut off valves provided at top & bottom should be opened. This will allow the radiators to be filled with clean and dry transformer oil.
- Air should be released from top of the header of each radiator. Close the air release plug after oil filling in radiator is complete and air release is finished. Ensure tightening of Air release plug.
- For corrugated tanks the condition does not apply as cooling part/radiator is an integral part of tank in form of corrugation.

3.12 CURRENT TRANSFORMERS (IF SUPPLIED):

- Before energizing the transformer, secondary circuit of any CT fitted MUST always be short-circuited or connected with the load circuit.
- When connected with the load circuit, ensure the CT shorting link is opened.
- When CT primary is energized with secondary winding open, excessive voltage will develop across the secondary circuit and damage the CT or become a safety hazard if touched.
- All CT secondary's not in use or available as spare must be kept shorted.

3.13 EARTHING CONNECTION:

- The tank should be permanently and effectively connected to earth by means of flat / flexible conductor of suitable size & materials (galvanized steel / copper / equivalent) terminated on earthing terminals / pads provided at the bottom of the tank, cable box, marshaling box, switch gear box, etc.
- Ensure earthing pad should be clean from dust/paint and moisture before connection.

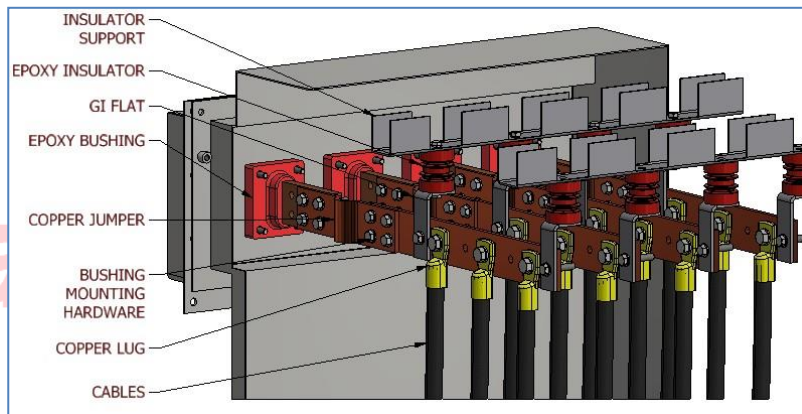
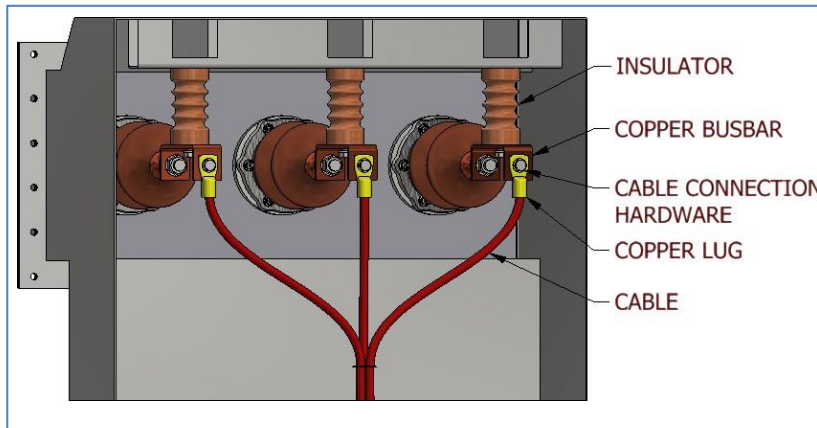


- Earthing connection(s) with a good low resistance is/are essential for adequate protection against electrical faults. All the earth connections should be of sufficient physical size to carry the line current. (Electricity rules and laws to be followed)

3.14 LV/HV CONNECTIONS:

- Cable termination/Connection points are clearly labeled on both high voltage (HV) and low voltage (LV) side of the transformer.
- Make only those connections specified by the nameplate or connection diagram, check all connections for proper location and tightness, and re-tighten all cable retaining bolts.
- Improper connection will cause heating and arcing which may result in connection failure. When connecting bus bars, make sure the joints are properly aligned prior bolting, to prevent excessive strain on the insulators.
- Bi-metallic lugs should be used in case of Aluminum cables and Copper bus-bars.
- Always use two wrenches (**with proper torque set**) while tightening or loosening bolted connections to prevent damage for all electrical & mechanical connections. This result in better symmetry of the tightening forces over the bolt & overstressing can be avoided. (Ref. table x for torque details).
- The cables should be supported separately to ensure that no-undue strain is exerted on the bushing terminals in the cable box.
- Cable should not be directly terminated through bushing stem as these results in excessive strain on the bushing leading to bushing damage or Oil leakage through gasket joint of bushing & tank.
- Cables should be terminated on bus-bars provided in a cable box and termination should not exceed the number of holes provided. In other words NO extra holes should be made in bus-bar at site.

- The cable should be clamped / supported by suitable cable glands. Care should be taken to ensure minimal stress on the bus-bar.
- Adequate support should be provided for Cables and Cable Box as per site requirements/arrangements.



3.15 PAINTWORK:

- All metal parts are properly cleaned, suitably surface treated and given three coats of high quality paint before dispatch from the works. The first, which is applied to the neat metal surface, is a primary coat, followed by an intermediate coat and then a final finishing coat as per relevant specification.
- If the paint-work has been damaged during transit or erection, touch-up painting should be done without delay to avoid any possible rusting of metal.
- Surface to be repainted should be thoroughly cleaned to remove any grease/rust.

3.16 COMPLETION OF OTHER INSTALLATION WORKS:

- Any work such as secondary wiring from Phase CT's / Neutral CT, wiring of alarm / trip contacts from accessories of the transformer to Marshaling Box, Control Gear Box, if/as required shall be completed at site.
- All the scheme wiring, relay settings, functional checks, etc., should be completed before the transformer is released for commissioning into service.
- For installation and fittings kindly refer to approved General Assembly drawing.

3.17 TORQUE TIGHTENING:

- It is recommended to use torque wrenches while tightening fasteners for electrical & mechanical connections. This result in better symmetry of the tension forces on the fasteners & overstressing can be avoided.
- All the fasteners should be tightened by using suitable Torque wrench w.r.t the following torque chart.
- Standard tightening sequence also needs to be followed.

Conservator Support	M10	HDG	24	+/-10%
	M12	HDG	40	+/-10%
	M16	HDG	90	+/-10%
Cable Box	M10	HDG	15	+/-10%
	M12	HDG	35	+/-10%
Cable Box Support	M12	HDG	40	+/-10%
Cable Box Busbar Fixing	M10	HDG	24	+/-10%
	M12	HDG	40	+/-10%
	M16	HDG	90	+/-10%
Porcelain Bushing fixing	M10	HDG	15	+/-10%
	M12	HDG	25	+/-10%
Porcelain Bushing Metal Part fixing	M12	Brass / Copper	13	+/-10%
	M20	Brass / Copper	30	+/-10%
	M30	Brass / Copper	70	+/-10%
	M42	Brass / Copper	110	+/-10%
	M48	Brass / Copper	180	+/-10%
	M56	Brass / Copper	250	+/-10%
Epoxy Bushing fixing & Terminal Board	M10	HDG	15	+/-10%
	M12	HDG	25	+/-10%
Inspection cover	M10	HDG	15	+/-10%
	M12	HDG	35	+/-10%
CT POCKET	M10	HDG	15	+/-10%
Radiator fixing	M16	HDG	85	+/-10%
Valve fixing	M12	HDG	25	+/-10%
	M16	HDG	85	+/-10%
B'relay fixing	M12	HDG	25	+/-10%
	M16	HDG	85	+/-10%
PRV	M10	HDG	15	+/-10%
MOG	M10	HDG	15	+/-10%
Breather	M10	HDG	15	+/-10%
Oil level gauge	M8	HDG	10	+/-10%
	M10	HDG	15	+/-10%
Roller	M16	HDG	90	+/-10%
	M20	HDG	*	+/-10%

4 COMMISSIONING:

4.01 PURPOSE:

- After the satisfactory completion of installation, the following pre-commissioning checks and tests on Transformer & instruments must be performed before putting the transformer into service.
- Only qualified personnel should perform these tests.



Danger
Electrical hazard

Improper testing by unqualified persons could result in serious injury or death.

4.02 COMMISSIONING TESTS:

- During testing, external power lines / cables, lightning arresters, neutral earthing, etc., should not be in the power circuit.
- Ensure that transformer is completely isolated at HV & LV sides and all non-current carrying conductors are earthed.
- Before starting this test all the power terminal bushings should be thoroughly cleaned with a dry & clean piece of cloth.

4.02.01 BREAK-DOWN VOLTAGE (BDV) TEST:

- Oil samples from tank bottom, tank top, radiator, etc. shall be carefully taken and tested for BDV.
- BDV value of oil should be more than 50kV (rms) in standard test cell by maintaining the gap of 2.5mm between electrodes.
- If BDV value is low, then it may be necessary to dry-out & clean the oil till the insulation reaches satisfactory values.
- Note: For very low IR values and low BDV values, it is recommended to contact manufacturer for suitable recovery procedure based on available facilities at site.

Sr. No.	Test Sample	BDV Value in kV
1		
2		
3		
4		
5		
6		
Average BDV in kV		

4.02.02 VOLTAGE RATIO TEST:

- Apply 3-Phase, Low voltage AC supply on the HV side and the Voltage Ratio at all tap positions can be derived using suitable precision voltmeter connected to the LV side. A ratio meter, if available can be used for a more accurate measurement.
- The Ratio values obtained should be similar to those indicated in the manufacturers' test report, furnished with the handing-over documents.

Tap No.	Voltage Applied (HV Side)			Voltage Measured (LV Side)			Ratio Obtained			Calculated Ratio from R & D Plate
	U-V	V-W	W-U	U-V	V-W	W-U	U-V	V-W	W-U	
First										
N										
Last										

4.02.03 MAGNETIC BALANCE TEST:

- Apply 230 Volts AC between each HV phase, keeping LV open. Measure HV Voltage for other remaining phases & record. A matrix will be formed as follows:

Applied voltage	U-V	V-W	W-U
1	230	XX	XX
2	XX	230	XX
3	Xx	XX	230

- The "X, x" denotes the place to record measured readings. Measure the current and record separately for each phase.

4.02.04 MEASUREMENT OF MAGNETIZING CURRENT TESTS:

- Apply 400 V from HV Side and check current per phase in milliamps. (This test is applicable only for Distribution type of Transformer)

Phase	Voltage Applied (V)	Current Measured (m Amps)	Remarks
U-V			
V-W			
W-U			

4.02.05 INSULATION RESISTANCE (IR) TEST:

- IR values of windings to earth & between windings shall be measured with designated insulation tester of suitable ratings and readings should be noted.
- For Class A insulation the Insulation Resistance gets halved for every 10 Degree Centigrade increase in temp.
- As a safe general rule the following values may be considered as satisfactory.

Rated Voltage kV	Minimum safe I.R. in MΩ				DC Voltage of IR Tester (V)
	30°C	40°C	50°C	60°C	
22 or 33	500	250	125	65	2500
11 or 6.6	200	100	50	25	1000
0.433	100	60	15	5	500

- IR values obtained should be similar to those indicated in the manufacturers' test report (comparison can be done on similar temp), furnished with the handing-over documents. In humid weather, IR values obtained may be lower due to condensation on the terminal bushings.
- If IR values are very low and unacceptable, then it may be necessary to filter the oil / dry-out the winding till the insulation reaches satisfactory values. This should be done in consultation with the Manufacturer.

4.02.06 WINDING RESISTANCE MEASUREMENT TEST:

- Winding Resistance between phase windings should be measured using suitable DC Resistive Bridge or similar.
- Winding Resistance values obtained should be similar to those indicated in the manufacturers' test report, furnished with the handing-over documents.

Winding	Tap No.	1U- 1V/ 1U-N	1V- 1W/ 1V-N	1W- 1U/ 1W-N	Temp.	Remark
Primary Winding	First					
	N					
	Last					
Secondary Winding 1	Tap No.	2u- 2v/ 2u-n	2v- 2w/ 2v-n	2w- 2u/ 2w-n	Temp.	Remark
	-					
Secondary Winding 2	Tap No.	3u- 3v/ 3u-n	3v- 3w/ 3v-n	3w- 3u/ 3w-n	Temp.	Remark
	-					
Secondary Winding 3	Tap No.	4u- 4v/ 4u-n	4v- 4w/ 4v-n	4w- 4u/ 4w-n	Temp.	Remark
	-					
Secondary Winding 4	Tap No.	5u- 5v/ 5u-n	5v- 5w/ 5v-n	5w- 5u/ 5w-n	Temp.	Remark
	-					

4.02.07 MARSHALLING BOX SCHEME CHECK (IF SUPPLIED):

- All the auxiliary wiring from accessories to marshaling box shall be checked with marshaling box scheme drawing furnished with the handing-over documents.
- During testing of accessories like buchholz relay, etc., operation of all the alarm / trip contacts shall be checked at marshaling box terminal blocks ensuring both operation and wiring are correct.

4.02.08 TEMPERATURE INDICATOR TEST:

- Indicators operation for alarm and trip contact shall be checked by manual stimulation.
- For a self-cooled (ONAN) transformer having a guaranteed temperature rise (at specified ambient temperature) at rated KVA, the recommended setting for the alarm and trip contacts of oil temperature indicator (OTI) and winding temperature indicator (WTI), are mentioned in the wiring diagram provided inside the marshaling box or as a part of approved GA drawing.
- However depending upon ambient temperature and loading conditions (other than specified) these settings can be changed by consulting manufacturer.
- For forced air cooled (ONAF) transformers, the recommended setting of the contacts of the WTI for control of cooling fans and the setting of the alarm and trip contact of the OTI, will be indicated in the transformer test certificate.

4.02.09 RECOMMENDED ADDITIONAL CHECKS PRIOR PUTTING TRANSFORMER IN OPERATION:

- Connections are tight and secure.
- Accessories are operational (OTI, WTI, Buchholz Relay, PRV, MOG, fans, space heaters, limit switches, etc.)
- Identical tap positions in both the Tap switches in case of 5 winding transformer, in case of Transformers with OLTC same tap numbering in OLTC, DM and RTCC.
- All the Oil Shut-Off Valves & radiator valves are OPEN and Draw-Off Valves are CLOSED.
- All Thermometer Pockets are near filled (85%) with oil.
- All radiators are completely filled with oil.
- Correct level of oil in the Bushings, Conservator, etc. (In case of Nitrogen filled transformers, oil level on tank).
- Desiccant color in breather is blue for blue silica-gel or yellow /orange for envirogel.
- Earthing connection for main tank, neutral bushing, marshaling box, control gear box, cable box, arcing-horn, etc., are correct.
- No excessive strain on bushing and termination bus bar.
- Arcing horn gap for bushings are correctly fixed (if provided).
- All CT secondary circuits are closed.
- Air cell (if applicable) is charged.
- Release air from air release plugs of Main Tank, Inspection covers, Radiator, Conservator, Buchholz Relay and its pipe line, Bushing and its turrets.(Air release sequence should start from the bottom most point going upwards covering all air release plugs) & check for BDV prior Energizing the transformer.
- It is recommended that the transformer is initially energized at NO-LOAD only (make sure secondary side of transformer is open circuit) and checked for any abnormalities for the next 6 to 8 hours.
- AFTER SWITCHING on no-load, if the Primary Side Circuit Breaker is tripped, investigate the cause thoroughly and re-energize the transformer ONLY AFTER ensuring that the fault is properly cleared & recheck the check inrush currents settings.
- If transformer operates satisfactory on No-Load condition then apply load gradually and observe for any abnormalities for the next 6 to 8 hours.
- Post satisfactory operation of transformer on-load up to 50% for the initial 4 - 8 hours, shut-down the transformer and ensure that all air-release plugs of tank, radiator, conservator, buchholz relay, bushings, etc., are free from air pockets which may have developed during initial loading.

5 MAINTENANCE:

5.01 GENERAL:

- Main objective of any preventive maintenance activity is to preserve the original properties of the materials in good condition. If a transformer is to give long and trouble-free service, it should receive a reasonable amount of maintenance, which consists of regular inspection, testing and reconditioning when necessary. Records should be kept giving details of any abnormalities during service and also of any periodic test results taken. This demonstrates compliance with the general requirements of ISO: 9000.

- Moisture, dirt, excessive heat / over-loading, mishandling, etc., are the main causes of INSULATION deterioration.



Danger
Electrical hazard

Maintenance work should be done on the transformer, with all the external circuits disconnected / made dead and all the windings are solidly earthed.

5.02 INSULATING OIL:

- Oil is a VERY IMPORTANT liquid being used both as a coolant & dielectric (insulant) in the transformer and thus keeping the oil in good condition will prevent deterioration of the paper & other such solid insulation materials immersed in it.

- IEC: 60422 - 'Maintenance of Insulating Oil' gives recommendations in detail for the preservation of insulating oil. A few short notes on the subject are given as below;

- a. Oil level should be checked at frequent intervals and any excessive leakage of oil must be investigated thoroughly. There may be a slight loss of oil by evaporation; this need not cause concern if the oil is topped up at regular intervals.

- b. All minor leaks or sweating should be repaired as quickly as possible.

- c. Oil shall be topped-up as per instruction of this manual. It is once again emphasized that any new oil to be added shall preferably be from the same source as the original oil. New oil from a different source may be added as make-up only but not exceeding about 10% of existing oil volume. In this case, suitable records should be kept.

- d. Samples of oil should be tested at regular intervals and results should be maintained.

- e. Dielectric strength alone does not give a true indication of oil condition. If dry, even highly deteriorated oil can give a high dielectric strength.

- f. Normal oil filtration method can maintain the dielectric strength only, but does not give indication for the deteriorated condition of oil. It is NOT advisable to rely solely on the dielectric strength of the oil by periodic test, without verifying its chemical composition. Reconditioning by centrifugal separation or filtration does not remove the acidity from oil but will remove moisture, sludge, dust, dirt, etc. and will tend to retard the process of deterioration.

- g. If the dielectric strength is below 30 kV (rms), the oil should be reconditioned by passing it through either a centrifugal separator or a filter. After reconditioning, the dielectric strength should be such that oil can withstand a minimum of 50 kV (rms).

- h. During oil filtration using a filter machine, make sure that the oil chamber of filter machine is free from dirt, sludge and residual water.

- i. It is recommended to confirm the fit & functioning of the Filter machine to avoid filter m/c problems. In order to ensure this, before connecting the filter m/c to transformer a filtration test must be conducted on oil in oil drum itself. If the machine working is fine and oil BDV of Transformer oil is improved the machine is fit to be connected to Transformer.

5.03 EXTERNAL — OUTDOOR / INDOOR TERMINAL BUSHINGS:

- At times during shut down and maintenance activities, outdoor Porcelain insulators/plugin bushings and rain sheds should be cleaned. Dry cloth can be used effectively to remove dirt / stains.
- During cleaning, the outdoor porcelain bushings should be examined for oil leakage, cracks or other defects and defective ones should be replaced.
- Arcing horns, if fitted, shall be checked for any arcing dents / welds and correct gap setting. And any arcing horn with dents / welds are to be replaced or rectified.
- Indoor Porcelain Insulators, usually placed inside the cable box, do not require cleaning under normal circumstances.
- Fit & functioning of the surge arrester and its earthing connections should be ensured.

5.04 CABLE BOXES (if supplied):

- In case of air-filled cable box (for Heat-Shrink / Push-On / other such dry termination), though no maintenance is required, it is advisable to check regularly for cleanliness, damages of bushings, tightness of termination, etc.

5.05 COOLING RADIATORS:

- Cooling Radiators should be checked for any oil leakages along all the welded joints, gasket joints, air release plugs, drain plugs.
- Any leakages, bend, dents, etc., should be rectified as soon as possible.

5.06 CONSERVATOR (if supplied):

- Conservators are arranged so that the lower part acts as a sump in which any impurities entering the conservator will tend to collect. A valve is fitted at the lowest point of the conservator for draining and sampling. When sampling, care must be taken to run off any such sludge before taking oil sample for testing.
- The inside of the conservator should be cleaned and a removable end is provided on each conservator for this purpose.

5.07 OIL GAUGES:

- Oil gauge should be kept clean and any damaged glasses should be replaced immediately. The gauges are normally fitted with strengthened plate glass which is unbreakable under normal service conditions.

5.08 DEHYDRATING BREATHER (if supplied):

- The dehydrating breather should be regularly checked for color of desiccant. When the majority of gel becomes saturated, the same shall be replaced or reactivated.
- Oil in the oil seal, if used, should be maintained up to the level marked on the cup.
- The frequency of inspection depends upon local climate and operating conditions. More frequent inspections are needed when the climate is humid and when the transformer is subject to fluctuating load.

5.09 BUCHHOLZ RELAY (if supplied):

- The relay should be routinely inspected and the operation of relay is ensured by injecting air into the relay and check that floats are able to fall / rise freely and that the mercury / magnetic switches are making / breaking the contacts.
- During service, if the relay is operated due to an accumulation of gas and not due to fall of conservator oil level, any internal faults can be identified to a great extent by a chemical analysis of gas. Sometimes, on analyzing the gas, it may be noticed that the gas collected is only air. This may be that the oil is releasing any absorbed air during oil filtration or due to change in temperature.

5.10 TEMPERATURE INDICATORS:

- The level of oil in the thermometer pockets should be checked and should be replenished, if required. The capillary tubing should be fastened down again if it has become loose. Dial-glasses of temperature indicators should be kept clean and, if broken, replaced. Temperature indicators if found to be reading incorrectly should be re-calibrated with standard thermometer immersed in hot oil bath.

5.11 SEALING GASKETS:

- The continuous use of transformer due to large variation in temperatures, operating & atmospheric conditions may cause over the years an oil leak. Such oil leaks usually disappear after small tightening of hardware in correct sequence and torque value.

- However it is also necessary to check the tightness of all bolts fitted with gaskets. The bolts should be tightened evenly around the joints by means of torque wrench to avoid uneven pressure. Damaged gaskets should be replaced.

5.12 BOLT, NUTS & FASTENERS:

- All bolts, nuts, fasteners, etc., shall be thoroughly checked for proper tightness and if found loose, should be tightened.

5.13 PAINT-WORK:

- During storage and service, the paint-work should be inspected once a year, especially at the welded seams / joints, and wherever necessary, painting or retouching work should be carried out.

- If the metal surface is exposed and becomes dirty, rusty or greasy because of delay in repairing the paint-work, the surface must be thoroughly cleaned with a wire-brush or similar abrasives, before repainting to ensure a good bond between metal and paint. If paints recommended by supplier are not available, any good quality alkyd resin-based paint can be used.

5.14 VALVES:

- All valves should be checked for any leakage and for open / close operation. Blind caps should always be kept fitted on them.

6 RECOMMENDED MAINTENANCE SCHEDULE FOR TRANSFORMER:

Sr. No.	Frequency of Inspection	Items to be Inspected	Inspection Notes	Action required for unsatisfactory conditions
1	Hourly / Daily	Ambient Temp.	For reference	-
2		Oil / Winding Temperature	Check that temp rise is within the limit	For any abnormal temp. rise trip, investigate the cause.
3		Load, Voltage & Current	Check against the rated figures	For any abnormal tripping, investigate the cause.
4	Weekly	Dehydrating Breather	Check desiccant color & oil seal	Replace the desiccant or make up the oil, as required.
5		Oil level in Main Tank	Check the level against oil temp.	If low, investigate the oil leak & top up with dry oil.
6		Buchholz Relay	Check gas collection	Take suitable action to prevent any potential fault.
7		Gasket Joints & Radiators	Check for tightness & oil leakage	Arrange for replacement /repair as required.
8		Explosion Vent / Pr. Relief Device	Check for proper sealing / indicator	Rectify / Investigate the damage / malfunction.
9	Quarterly	Oil	Check for dielectric strength / sludge	Take suitable action to restore quality of oil.
10		Cable Box / Terminal Bushings	Check for tightness / dirt / damage	Clean thoroughly, if needed, take remedial measures.
11		OCTC/OLTC	Check for smooth operation	If required, replace oil / worn- out parts.
12	Half Yearly	Earthing Terminals	Check tightness & Earth Resistance	Take remedial action if earth resistance is high
13		Accessories / Auxiliary Circuits	Check operation & switching contacts.	Clean the components, if found faulty, replace the item.
14	Yearly	Buchholz relay / Surge relay	Mechanical inspection	Check floats, contact switch operation
15		Insulation Resistance	Check IR values	If low, investigate & take action to restore insulation
16		Fastening Bolts / Screws / Clamps	Check for tightness	Tighten if found loose, replace the defective fasteners
17		Paint-work	Check for peelings / rusting/ damage	Repaint, as required.
18	Two Years	Temperature Indicator	Check operation & switching contacts.	Clean the components, if found faulty, replace the item.
19		Oil Gauge.	Check operation & switching contacts.	Clean the components, if found faulty, replace the item.
20		Oil conservator	Internal inspection	Clean if necessary
21	3-5 Years	Overall paint-Work	Check for deterioration	Consider full repaint to match original specification
22		OCTC switches	Check for arcing / welding / wearing	Replace / Repair defective components as necessary
23		Core & Windings	Check for tightness / cleanliness	Replace / Repair defective components as necessary

* Apart from above table, respective accessories manuals should be referred for maintenance schedule.

7 DETAILS TO BE FURNISHED BY CUSTOMER IN CASE OF TRANSFORMER FAILURE:

#	Details Required	Remarks
1	Transformer Sr. No.	
2	Date & Time of Failure	
3	Failure occurred instance:	
3.1	i. Charging	
3.2	ii. Operation	
3.3	iii. Switching	
4	Date of Installation	
5	Date of Commissioning/Charging	
6	Load condition on Transformer at the time of failure:	
6.1	i. No Load	
6.2	ii. Part Load	
6.3	iii. Full load	
6.4	iv. Over Load	
7	Transformer Test report at the time of commissioning	
8	Environmental conditions at Site:	
8.1	i. Humid	
8.2	ii. Dusty	
9	Single line diagram (SLD) of transformer feeder	
10	Details of Preventive maintenance	
11	Abnormality records (if any) in the past history based on Log book	
12	Tripping record at time of transformer charging (if any)	
13	Transformer protection system details	
14	Breaker details	
15	CT details in breaker:	
15.1	HV	
15.2	LV	
16	RC circuit or Snubber circuit	
17	Relay details	
17.1	Relay Settings in HV (CT multiplier - Overcurrent, Instantaneous, Time delay settings - Overcurrent I>, Instantaneous I>>)	
17.2	Relay Settings in LV (CT multiplier - Overcurrent, Instantaneous, Time delay settings - Overcurrent I>, Instantaneous I>>)	
18	Installation room photos with transformer	
19	Visual flash marks over the transformer(if any), Photographs	
20	Failure details of any other equipment in the system	

8 DISPOSAL:

- All material soaked in oil is hazardous in nature and is to be disposed through authorized waste disposal agencies.
- Used transformer mineral oil should be disposed through authorized waste disposal agencies to avoid any environmental hazards.
- All steel components, CRGO & Copper are to be disposed through authorized re- cyclers.
- For further details and guidance on waste disposal customer may contact RRPL.

9 GENERAL NOTES:

- It is essential to keep a record of observations made regarding operating condition, any test parameters & test results obtained.
- In case of any abnormality occurring during service, advice from the suppliers should be obtained, giving them name-plate particulars and complete details as to the nature & the extent of occurrence.
- Customers are hereby advised to contact us by letter/ fax/ e-mail / phone in case of any doubt before doing something wrong at the time of installation / commissioning to avoid any damage to the transformer.
- We value our customer feedback which can help us serve better.

Raychem **RPG**

Gat No. 426 / 2B, Chakan – Talegaon Road, Mahalunge Village, Taluka Khed, Dist. Pune – 410 501, India
Tel: +91 2135 399323/325, Web: www.raychemrpg.com

Warranty Terms & Conditions

Raychem RPG Pvt. Limited. ("Raychem RPG") provides the following warranty with respect to Transformer. Transformer will be free from defects in material and workmanship for a period of 12 (twelve) months from the date of Installation & 18 (Eighteen) from the date of invoice whichever is earlier. Extended Warranty can be provided to customer only if they agree to pay the warranty costs as highlighted at the time of order finalization. The requirements of warranty must be brought out to notice of Raychem RPG at the time of order finalization. Under no circumstances, the warranty of supplied transformers shall be extended after final issue of PO/contract signing. Raychem RPG, in its sole discretion will repair the transformer that Raychem RPG and Buyer mutually agree contains a defect in material and workmanship.

Raychem RPG's warranty obligations shall be subject to and contingent upon the following:

- The transformer shall be installed in accordance with Raychem RPG's instructions, in accordance with any other applicable instructions (to the extent not in conflict with Raychem RPG's instructions), and in accordance with good industry practice.
- Customer must buy the service of "Supervision of Erection Testing & commissioning of transformers" at site & set of recommended spares at advised by Raychem RPG.
- Buyer must store & maintain the recommended spare parts / spare transformers at the site under appropriate storage conditions at their own cost.
- The transformers must be operated & maintained as per Raychem RPG's instructions. Under no circumstances, the maintenance of transformers at site shall not be a part of the warranty.
- Transit damage should be reported to Raychem RPG within one week from transformer received at site (as per PO incoterms of delivery), otherwise the product is deemed to be delivered in good condition & no claim if any transit damage / defect shall be accepted & Customer has to inform/ share charging date and pre-commissioning / commissioning test / observation reports with Raychem RPG Pvt. Ltd.
- In event of any claim pursuant to this warranty, buyer must submit a formal Non-Conformity Report through email with proper photographic evidence of the issue, job no., site conditions, and any /all data as required by Raychem for technical analysis. Post submission of this report Raychem RPG, shall revert within 24-72 hours, assess the issue and provide solution through emails / telephone calls. If required, Raychem RPG shall be provided an opportunity to inspect such transformer as installed and Raychem RPG shall have the right for Inspection and Testing of the Transformer at site or at its premises, as required.
- The warranty is expressly excluded for and / or defect of the transformer arising from or consisting in:
 - a. Any repair, alteration and/or modification not authorized in writing by Raychem RPG
 - b. Normal wear and tear of the material or of the singles components.
 - c. Improper use and/or application of the transformer
 - d. Excessive thermal, electrical or mechanical stress, although when occasional, beyond the limits of performance of the transformers.
 - e. Failure due to dust, metallic dust, moisture or foreign material or particles.
 - f. Defect and/or mistakes in the technical specifications, if any supplied by the client or by third parties entrusted by the client.
 - g. Negligent maintenance of the transformer; Installation not in compliance with Raychem RPG instructions.
 - h. In case of Earth pit resistance > 1 ohm.
 - i. Failure to comply with any functional and environment parameter indicated by Raychem RPG for the correct functioning of the transformer;
 - j. In case of IP 00 supplied transformer failure due to dust, metallic duct, moisture or foreign material or particle
 - k. In case of defects in the electrical instrument E.g. : Cooling fan, Bushing , Buchholz relay, WTI , OTI, MOG, PRV, All Valve, Heater, Thermostats, Sensors, Contactor, Indicators, fuses, Lamps, Switches, OCTC, OLTC & RTCC warranty will be applicable only for a period of 12 (twelve) months from the date of Installation & 18 (Eighteen) from the date of invoice.
 - l. Any uptime power guarantee at site.
 - m. Shifting / re-installation of transformers or installation of spare transformers at site due to any reason and expenses associated with the same.
- In the event of failure of any transformer at site under the warranty, Raychem RPG's liability shall be limited to technical analysis of the root cause of the failure. The buyer must provide all the suitable technical data, site incidences reports etc. as required for the analysis.
- In any case the aggregate Raychem RPG's liability for damages arising out of vices and/or defect of the transformer under contract shall not exceed their aggregate price/total contract value.
- Except as provided in the preceding paragraphs, Raychem RPG makes no warranties of any kind whatsoever either express or implied, including without purpose. Raychem RPG's sole liability to buyer shall be for a repair of transformer, and in no event will Raychem RPG be liable for expenses, liabilities or losses associated with the Installation or removal of transformer, or the Installation for loss of profits, loss of use, or incidental expenses, interest, consequential or special damages of any kind.