



INSTALLATION AND
MAINTENANCE GUIDE
FOR OIL FILLED
TRANSFORMERS

IMPORTANT SAFETY INFORMATION

Read these instructions carefully and become familiar with the equipment before proceeding with installation, operation, or maintenance activities. This equipment contains extremely hazardous voltages. To prevent death, serious personal injury, or equipment damage, all information in these instructions should be read and observed. Safe use of this equipment is dependent on proper installation, operation, and maintenance procedures.

Certain information in this manual is marked with the following symbols, which indicate hazards.



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious personal injury and may result in damage to the equipment.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious personal injury and may result in equipment damage.



Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate personal injury and may result in damage to the equipment.

All work on the units must be carried out by trained/qualified personnel, as per the local regulations. Installation and maintenance manual must be kept with unit at all times. Ensure that instruction manual is understood before installation. Ensure working environment is suitable.

Use suitable PPE (Personal Protection Equipment) as per site regulations and as appropriate for the task. It is the responsibility of the person performing the task and their employer to ensure that all suitable PPE is provided and worn at all times.

IMPORTANT INFORMATION ABOUT THESE INSTRUCTIONS

Personnel should not attempt to service this equipment until it has been effectively de-energized, and all high-voltage and low-voltage bushing terminals have been properly grounded. Only qualified personnel should install, maintain, and operate this equipment. Qualified personnel are those who are trained in the installation, maintenance, and operation of high-voltage equipment, trained in the proper use of personal protective equipment (such as rubber gloves, safety glasses, protective clothing, hard hats, etc.) and trained in appropriate first aid procedures.

The instructions contained herein are intended to be a general guide for the installation, operation and maintenance of this equipment, when operated in "Usual Service Conditions" as defined in IEC 60076 Standard. Although efforts have been made to ensure accuracy and completeness, these instructions do not address every conceivable application or circumstance that might be encountered.

INDEX

1) INTRODUCTION	3
2) HANDLING	3
a) Unloading Transformers	3
i) Lifting	3
b) Visual Inspection	3
c) Storage	4
3) ERECTION & COMMISSIONING	4
a) Site Preparation	4
b) Precautions	4
c) Equipment required	5
d) Testing	5
i) Insulation Resistance	5
ii) Continuity tests	5
iii) General Checks	5
e) After Commissioning	6
4) ACCESSORIES & FITTINGS	7
1) H.V Bushing	7
2) L.V Bushing	7
3) Lifting Lugs	8
4) Oil Level Indicator	8
5) Corrugated Panel	8
6) Rating and Connection Diagram Plate	8
7) Earthing Terminals	8
8) Base Channels	8
9) Drain Valve with Closing plug	8
10) Off-Circuit Tap Switch	9
11) Pressure Relief Device	9
12) Pole Mounting Brackets	9
13) Surge Arrester Mounting Brackets	10
5) MAINTENANCE	10
a) General	10
b) Maintenance Procedures	10
i) Oil	10
ii) Bushings	11
iii) External Connections	11
iv) Gaskets	11
v) Temperature Indicators	11
vi) Physical Inspection	11
c) Recommended Schedules	12
6) TROUBLESHOOTING	13
7) DISPOSAL	13

1) INTRODUCTION:

This manual has been prepared to assist competent technicians in the installation, operation and service of primary or secondary unit- or open-type substation transformers.

Although every effort has been made to anticipate normal installation, operation and servicing problems, these instructions do not cover all possible variations in equipment or application conditions. Not all possible installation, operation or service contingencies are discussed. If additional information is required, contact a factory representative. It is important that personnel using these instructions be fully acquainted with industry accepted high and low voltage safe operating practices and procedures. These instructions are not intended as a substitute for proper training or adequate experience in the safe operation of the equipment described.

2) HANDLING:

After testing and inspection at our work, transformers are dispatched from the works ready for taking into service. According to the transport facilities available for the route, transformers are transported either by rail, road or sea.

Transformers after processing and testing are dispatched from the factory completely filled with oil, ready for service. In case of large transformers, larger fittings like conservators, radiators are dismantled to facilitate proper transportation. In such cases, the oil for the dismantled components are sent in sealed drums.

a) Unloading Transformers

i) Lifting

For lifting of transformers, use lifting lugs as specified in the outline general arrangement (OGA) drawing (Refer Figure 1). Transformer should be unloaded using mobile (or) overhead cranes or other lifting devices of sufficient capacity. Parts other than the lugs should not be used for lifting. Transformers should be lifted in an upright position, allowing no more than 15 degrees of tilt from vertical. The slings on the eyes must form a minimum angle of 60° with the transformer's horizontal.

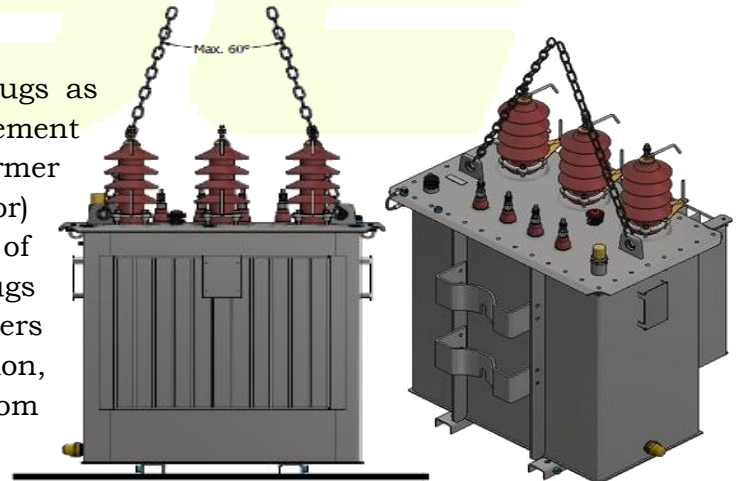


Figure: 1 – Handling of Transformer



WARNING All lifting hooks provided on the transformer must be used simultaneously. The transformer must not be lifted from any points other than the provided lifting hooks.

b) Visual Inspection

The transformers are dispatched as per the requirement. Before unloading the transformer from the carriage, examine if there are any missing parts or damage like

leaks, cracks, loose nuts etc. and if there is, inform the manufacturer before starting repair. The transformer is designed and manufactured to have sufficient strength to stand any vibration in transit, and so if no abnormality is found after checking every part, it can be installed, commissioned & operated.

c) Storage

All accessories should be stored in a covered dry place. All pipe work, conservator, radiators should be stored with their blanking plates which prevents entry of water & foreign particles. Heaters in the marshalling box should be kept energized to avoid condensation. If the erection and commissioning is undertaken beyond one year or so, repainting is recommended to avoid rusting.

3) ERECTION & COMMISSIONING

a) Site preparation

The transformer should be erected on a level foundation or surface, which should be designed by a structural or civil engineer. It should be able to bear the weight of the transformer and prevent accumulation of water.

The transformer should be installed with easy all around access. All instruments and valves should be easily read and operated. Sufficient clearances from various live points of the transformer to earthed parts should also be maintained as per local electricity rules.

For transformers installed indoors, the room must be well ventilated, so that hot air can escape easily and is replaced by cold air.

b) Precautions

- Transformer oil is inflammable. Under certain circumstances and in a confined space, the oil may become explosive. Hence, naked lights and flames should never be brought near the transformer.
- As far as possible, no work should be carried out during the monsoon to avoid moisture absorption by the transformer. Extreme care should be taken to prevent any foreign material from being dropped into the transformer. Workmen/engineers with access to the interior of the transformer should empty their pockets of any loose articles. Spanners and other tools used should be tied with strings to the hand of the workmen, so that they can be recovered if accidentally dropped.
- Fibrous cleaning material should not be used, since the presence of loose fibres suspended in oil can reduce its insulating properties. If any cleaning or wiping is necessary, it should be done with clean dry cloth for wiping, before fitting on transformer.

- The transformer oil and cellulose based solid insulation normally used in transformer construction absorb moisture easily, particularly when cold. If access is needed to the interior of the tank during erection the transformer is best protected from moisture hazards by circulating dry and hot transformer oil until temperature is slightly above the ambient, prior to allowing access to the interior.
- The transformer shall be erected on a level foundation.

c) Equipment required

The tools and equipment required at the site for erection and commissioning of transformers are as follows:

S.No.	Equipment / Supplies	Qty	Remarks / Purpose
1.	Oil BDV testing	1	<ul style="list-style-type: none"> • To check BDV of oil up to 60 kV across 2.5mm gap (IEC 60296)
2.	Filtering machine	1	<ul style="list-style-type: none"> • Required only for transformer assembled at site • Capacity – 2000 LPH • Particle size <2 mm microns
3.	Carbon Tetra Chloride		<ul style="list-style-type: none"> • For cleaning bushings

Table: 1 – Additional equipment required for erection and commissioning of transformers

d) Testing

If the foregoing instructions have been carefully followed, the transformer can now be safely put into service after pre-commissioning tests as mentioned below.

i) Insulation resistance

IR values between windings and between windings to earth are to be checked; while checking these values no external lines, lightning arrestors etc., should be in circuit. Bushings are thoroughly cleaned before taking IR values. A 2500/1000/500 volts Megger preferably motor operated should be used for measuring IR values. Care should be taken that the lead wires of the Megger do not have joints.

ii) Continuity tests

Continuity of HV windings and LV windings of the transformer are to be tested, with megger or multimeter.

iii) General Checks

- All oil valves are in correct positions, closed or opened as required
- All air pockets are cleared / air releasing
- Thermometer pockets are filled with oil
- Oil is at correct level in the transformers
- Earthing connections are properly done
- Arcing horn gaps on bushings are properly adjusted

- Bushing surface to be cleaned using CTC.
- Tightening of bushing external connection cable to avoid leakages.
- Check the transformer fittings and accessories with respect to OGA.
- For breathing type transformers, check the condition of silica gel. Fill oil in the oil cup of the breather.

If all the above tests / checks are found satisfactory, allow a settling time of at least 24 hours for oil and release air from all points wherever applicable. Now the transformer can be energized after ensuring all connections are made strictly as per the requirement. Wherever possible, the voltage should be built up in steps. Any abnormality during commissioning such as vibration of parts, hum etc., should be observed. After a few hours of energization at no load, the load can be applied. If any abnormalities noticed, transformer shall be switched off, should be corrected. Transformer should not be re-energized suddenly and loaded gradually.

iv) After commissioning

After successful commissioning of the transformer, the following details should be furnished to the manufacturer:

- Details of transformer, including its serial number.
- Date of commissioning, with test results.
- Substation / Generating station, where commissioned.
- Protection given to the transformer such as lightning arrestor, differential protection, circuit breaker on HV / LV etc.

4) ACCESSORIES & FITTINGS:

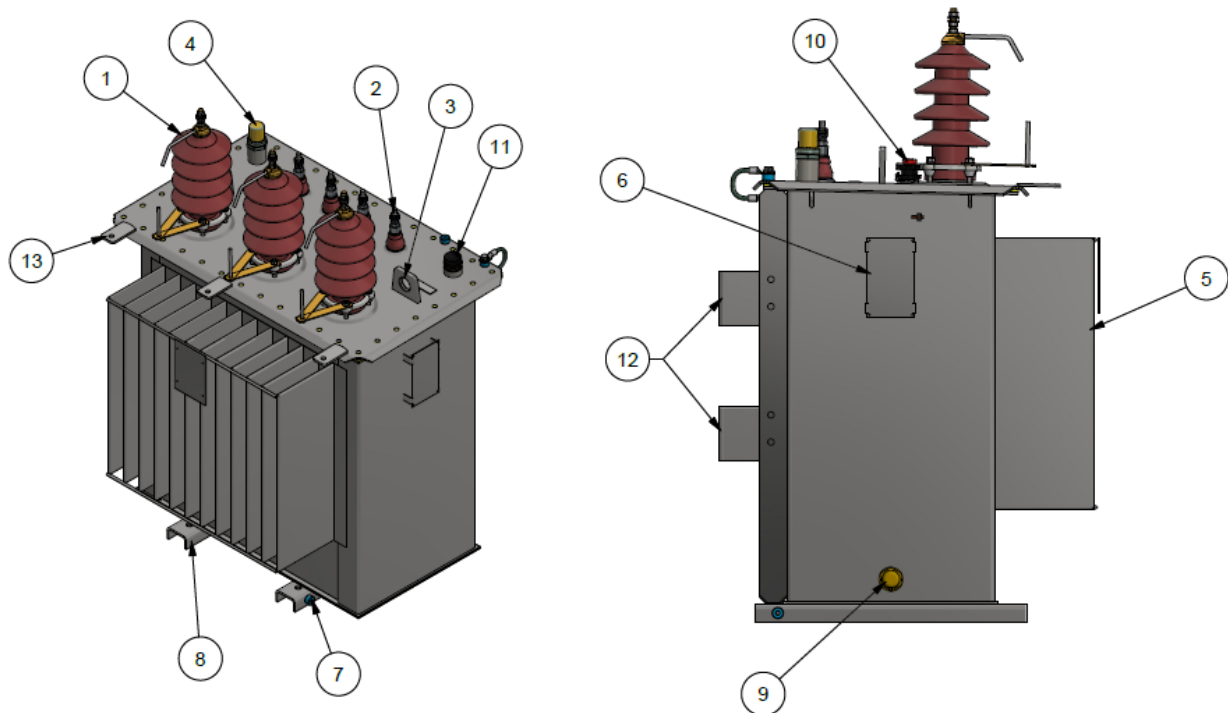


Figure: 2 – Accessories & Fittings of a Transformer

List of accessories & fittings furnished with the transformer:

- | | |
|--|--------------------------------------|
| 1) H.V Bushing | 8) Base Channels |
| 2) L.V Bushing | 9) Drain Valve with Closing plug |
| 3) Lifting Lugs | 10) Off-Circuit Tap Switch |
| 4) Oil Level Indicator | 11) Pressure Relief Device |
| 5) Corrugated Panel | 12) Pole Mounting Brackets |
| 6) Rating and Connection Diagram Plate | 13) Surge Arrester Mounting Brackets |
| 7) Earthing Terminals | |

1) High Voltage Bushings & 2) Low Voltage Bushings

Transformers windings are connected to the external circuit through terminal bushings. Bushings are installed either on the top cover or on the side walls of the transformer tank. Lower end of the bushing protrudes into the tank. The shape and the size of the bushing depend on the voltage class, type of current.

Use 2 appropriate wrenches to tighten the 2 nuts on the porcelain bushing rods and firmly fix the cable lug. Do not, under any circumstances, touch the 3rd nut used to fix the porcelain bushing cover

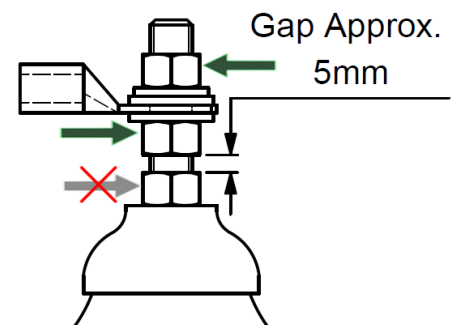


Figure: 3 – Bushing Cable Lug Connection

Care must be taken in handling the bushing to avoid cracking the porcelain or damaging its surface. When replacing bushings, new gasket shall be used.

⚠ WARNING

Do not exceed the cantilever load rating of the bushing. Greater loads may cause bushing damage that could result in severe personal injury, death, or property damage.

3) Lifting Lugs:

Two/Four lifting lugs of adequate capacity are provided on tank sides/top cover to lift fully assembled transformer filled with oil. All lugs are designed for simultaneous use and must be used accordingly. Two/Four lifting lugs are provided for un-tanking the core and windings of larger capacity transformers.

4) Oil Level Indicator

Transformers are provided with oil level indicator with a highly visible red float. The float provides the indication of oil level in the tank. The transformer tank is filled with fluid at the factory to the normal level. If the oil level in the gauge indicated low level, the cause of the same should be investigated and corrected.



Figure: 4 – Oil level indicator

⚠ WARNING

Always maintain proper oil level while the transformer is energized.

5) Corrugated Panel

Corrugated Panel serves as a tank body, which acts as an excellent Heat Exchanger. Handle it with care. Do not hit, lift or place weight on corrugated panel.

6) Rating and Connection Diagram Plate

The transformer is provided with a rating and terminal marking plate made out of non-corrosive metal. The plate contains certain physical & electrical information of transformer concerning the rating, voltage ratio, weights, oil quantity, vector group, etc.,. The plate also includes unit Sr. No. and year of manufacturing.

7) Earthing Terminals

The core lamination assembly is connected to core clamping frame, which is in turn connected to the tank. Two earthing terminals are provided on the transformer tank. The earthing terminals should be connected to the earthing.

8) Base Channels

Two base channels are provided, at the bottom of transformers, for lifting and movement of the transformers. Some transformers have rollers fitted to the base channels for easy movement.

9) Drain Valve with closing plug

Drain valve is provided at bottom of the tank. Valve is fitted with closing plug. These are of gun-metal/cast iron type.

10) Off-Circuit Tap Switch

Off circuit tap changer is used to adjust the voltage ratio of the transformer while the transformer is in de-energized position. It is intended to allow adjustment of secondary voltage to the rated value. The tap changer is operated by use of a rotating handle mounted outside the tank on top cover or side sheet. Never operate an off circuit tap changer while the transformer is energized. Refer to the transformer name plate, if available, for the details of tap position numbers and corresponding voltages. A locking mechanism is provided to lock the tap changer in position and to prevent accidental operation. The transformer is shipped from the factory with the tap changer in the rated voltage position, unless otherwise specified by the customer.

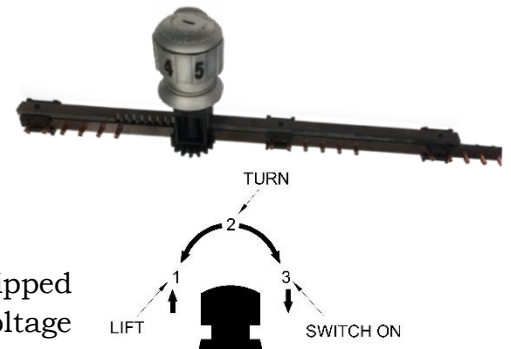


Figure: 5 – Off-Circuit Tap Switch

To Operate, (1) Lift the knob, (2) Turn to desired tap position and (3) Release it. The correct position is guaranteed once the arrow sign on the tap changer is perpendicular to the position number on the knob.

⚠ DANGER

- Do not operate the tap-changer while the transformer is energized. Doing so can result in severe personal injury and equipment damage.
- Do not re-energize the transformer unless the tap changer is firmly locked into position.

⚠ WARNING

Do not try to turn further the tap changer beyond first and last position

11) Pressure Relief Device

Transformers are equipped with pressure relief device to relieve excessive tank pressure that might occur during operation of the transformer. When the pressure inside the tank exceeds PRD's specified limit, diaphragm will open and vent the excess pressure. When the pressure falls below permitted limit, PRD will reset to its original position. The cause of PRD operation should always be investigated, since pressure venting indicates a potential problem inside the transformer.



Figure: 5 – Pressure Relief Device

⚠ WARNING

- The cause of PRV or PRD activation should always be investigated, since pressure venting indicates a potential problem inside the transformer.
- Personnel should wear eye and skin protective equipment when using the PRV to relieve tank pressure. Hot fluid may be expelled.
- Do not attempt to disassemble a PRD. Internal components may be under high spring pressure, creating a potential hazard from flying objects.

12) Pole Mounting Brackets

Transformers are equipped with two number of detachable pole mounting brackets, for installation on pole. They are firmly fixed to the transformer, with bolt arrangement. Ensure tightness of bolts during installation.

⚠ DANGER

- During installation on pole, transformer must be fixed using both top and bottom pole mounting brackets.
- Ensure tightness of bolts during installation of transformers, using pole mounting brackets.

13) Surge Arrester Mounting Brackets

Surge arrester mounting brackets are provided on HV side of the transformer, for installation of surge arresters during service.

5) MAINTENANCE:

a) General:

If a transformer is to give long and trouble-free service it should receive a reasonable amount of attention and maintenance.

b) Maintenance Procedure

⚠ CAUTION

- Under any circumstances, work on the transformer should never be undertaken unless it is disconnected from all external electrical circuits and all windings have been solidly earthed.
- Naked lights and flames should be kept well away from the transformer while working

i) Oil:

Transformer oil is subjected to deterioration or contamination in storage and in service. Accordingly, a periodic treatment to maintain it in fit condition is required, and eventually, it may have to be replaced by new oil. The causes of oil deterioration and recommendations for various tests are comprehensively covered in IEC: 60422. Reference shall be made to the same regarding the maintenance of quality oil in service.

Few tips given below may serve as ready reference.

- The oil level should be checked at frequent intervals and any excessive leakage of oil investigated.
- All leaks should be repaired as quickly as possible so as to avoid possible trouble caused by low oil level.
- Oil for topping up should comply with IEC: 60296 and should preferably be from the same source as the original oil because the oil refined from different crudes may not be completely miscible and may separate into layers. Furthermore, there may be a greater tendency to form acidity or sludge in a mixture than in oil from single source of supply. Used oil shall not be mixed.
- New oil may be added as make up only, not exceeding about 10 percent. It is desirable not to mix oil taken from a transformer with that from switchgear equipment.
- Samples of the oil should be taken at regular intervals and tested for BDV When tested in accordance with IEC: 60296, electrical strength (BDV) should not be less

than 60 kV RMS. This test should be carried out six times on the filled sample cell. The arithmetic mean of the six results should be used.

- When transformer is opened or the IR values are low, it shall be filtered for 2 passes and sealed after topping up. Then the transformer is cooled down to ambient temperature, the oil level shall be reduced to normal fill level.

ii) Bushings:

Clean the porcelain bushing and examine them for cracks and chips. Very slight chips may be ignored but any serious damage will require new porcelain which must be obtained from the manufacturer. It is recommended to have a spare in stock.

iii) External connections:

All connections should be tight. If they appear blackened or corroded, undo the connections and clean down to bright metal with emery paper.

iv) Gaskets:

Gaskets may shrink during service. It is, therefore, necessary to check the tightness of all bolts fastening gasketed joints. The bolts should be tightened evenly round the joints to avoid uneven pressure. Leaking gaskets should be replaced with new ones.

v) Physical Inspection:

The transformer tank, cover and other parts should be inspected periodically for oil leakage, peeling of paint or rust formation. Rusted portions should be properly cleaned and repainted. Oil leakage should be immediately attended to. Clamping bolts on gasketed joints should be tightened properly and if required, damaged gaskets replaced with new ones. Leaks through welded joints should be stopped by re-welding, this should be done without any oil in the transformer tank and cooling equipment.

c) Recommended Schedules

Recommended maintenance schedule is given below

Sl. No.	Inspection Frequency	Items to be inspected	Inspection Notes	Action required if inspection shows unsatisfactory conditions
1.	Hourly	Ambient Temperature & Oil temperature	Check whether the temperature rise is reasonable	Shut down the transformer and Investigate if either is persistently higher than normal.
2.	Hourly	Load current & voltage	Check load side current & voltage with reference to rated values	Load shall be controlled for high load current. Adjust tap position to obtain rated voltage.
3.	Daily	Oil level in transformer tank	Check against transformer oil level and leakages if any.	If oil level is low, top up with dry oil after attending leakages if any.
4.	Quarterly	Oil in transformer	Check for dielectric strength and water content.	Take suitable action to restore quality of oil.
5.	Quarterly	Bushing	Examine for cracks	Clean or replace as necessary
6.	Yearly	Oil in transformer	Check the acidity and sludge	Filter or replace oil.
7.	Yearly	Winding	Check insulation resistance.	Filter oil & ensure proper Megger value.
8.	Yearly	Gasket joints	Visually check all gaskets for cracking or other signs of deterioration	Replace as necessary with new gaskets. Do not re-use old gaskets. Tighten the bolts evenly to avoid uneven pressure.
9.	Yearly	Fasteners	Check for any signs of corrosion	Replace as necessary.
10.	Yearly	Painting	Inspect for any damage in paint	Repainting or retouching should be done if necessary.
11.	Yearly	Earth resistance	---	Take suitable action if earth resistance is high.
12.	3 years	Complete transformer	Servicing	Overall inspection including Core Coil Assembly.

Table: 2 – Recommended Maintenance Schedule

6) TROUBLE SHOOTING:

Faults observed during the periodic maintenance schedules are to be rectified as per the suggested action required. However, certain chance troubles and major faults in performance of the transformer shall have to be attended to in a desired sequence, as per manufacturer's instructions (or) ready reference manuals. Guidance to manage electrical and mechanical troubles normally encountered in all types of transformers are provided as follows:

Trouble	Cause	Remedy
Rise in temperature / High temperature in oil & winding	Over load	If possible, reduce load. Heating can often be reduced by improving power factor of load.
	Sludge in oil	Use filter press to wash off core and coils. Filter oil to remove sludge.
Audio noise	1. Leaky gaskets and joints. 2. Accessories & external transformer parts are set into resonant.	Make certain all joints are tight. Tighten loose parts. In some cases parts may be stressed into resonant state. Releasing pressure and shimming will remedy this condition.
Fractured metal or porcelain parts of bushings	Unusual strains placed on terminal connections	Cables and bus-bars attached to transformer terminals should be adequately supported. In the case of heavy leads, flexible connections should be provided to remove strain on the terminal and bushing porcelain part.
Oil level	Due to leakages or pilferage in gasket and welded joints	Cause of leakages to be checked and proper action to be taken

Table: 3 - Guidance to manage electrical and mechanical troubles

7) DISPOSAL:

Comply with all local, state and federal regulations when disposing of any insulating fluid. Fluid type and volume can be determined by referring to the transformer nameplate. Refer to appropriate fluid Safety Data Sheet (SDS). The SDS identifies fluid composition and properties, and describes important safety, handling and storage, ecological, regulatory, disposal and other pertinent information.



WARNING Improper disposal of a transformer could result in personal injury or death and could be hazardous to the environment.



CONTACT DETAILS:

If you need to contact us for any reason, please use the following:

Telephone : +91 40 66255266, +91 8886711140

Email : ibd@ssel.in, marketing@ssel.in

Address : Shirdi Sai Electricals Limited,

Corporate Office:

#6-3-8-879/B, 3rd Floor, G Pulla Reddy Sweets

Building,

Green Lands Road, Begumpet, Hyderabad, India –

500016.

Works:

Plot No. 53-55 & 58-60, Industrial Development
Area, Kadapa, Andhra Pradesh. India – 516002

Our Vision:

To build a sustainable organization that cater to the emerging needs of Energy sector

Our Mission:

We are focused on product and process innovation to meet customer's expectation on sustainable basis

- Leveraging our competence, experience and expertise for safer, reliable and cost effective solutions
- Investing in People, Technology and Processes
- Lead by action on social responsibility



ABOUT SSE

- Established in **1994** at Kadapa, Andhra Pradesh, India
- An **ISO 9001: 2015 & ISO 14001:2015** certified company
- Annual Revenue of **176 Mn.* USD**
- **1000+** workforce** in Manufacturing & **1500+** workforce** in EPC division
- Completely **Backward integrated facility** with **automation**, covered area of **65,000 Sq. Meters**
- Manufacturing capacity of **600** Distribution Transformers / day (REC Range)
- Installed base of **4,00,000+** Transformers
- **3** patents applied
- **Largest manufacturing facility** in INDIA for Energy Efficient **Amorphous Transformers**
- **Largest EPC Player** in HVDS Projects
- Erected **70,000 Km** of LT & HT Lines up to 132 kV





SHIRDI SAI ELECTRICALS LIMITED

Corporate Office:

#6-3-8-879/B, 3rd Floor, G Pulla Reddy Sweets Building,
Green Lands Road, Begumpet, Hyderabad, India – 500016.

+91 40 66255266

Works:

Plot No. 53-55 & 58-60, Industrial Development Area,
Kadapa, Andhra Pradesh. India – 516002.

+91 8886711110

Contacts:

Phone: +91 40 66255266, +91 8886711110
ibd@ssel.in, marketing@ssel.in