



OPERATION AND MAINTENANCE MANUAL

for hermetically closed oil-filled distribution transformers
ОВП.460.039

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Table of contents

1. Preface	3
2. Technical data	3
Operating conditions of transformers	3
Rated frequency	3
Higher voltage	3
Unacceptable operating conditions	3
Loading of oil-immersed transformers	3
Short-circuit withstand capacity	3
3. Design and features	4
Core	4
Windings	4
Tap changer	4
Tank	4
Cover	4
Insulating Oil	5
4. Transportation and lifting	5
Transportation	5
Lifting	5
5. Commissioning and start-up	5
Visual Inspection	5
Installation	5
Connecting of the transformer and preparing for start-up	5
Transformer start-up	6
6. Transformer operation and maintenance	6
Voltage regulation using off-load tap changer	6
Maintenance of unused transformers	6
Oil sampling	7
Frequency and scope of inspections	7
7. Troubleshooting	8
8. Documents delivered with the transformer	8

1. Preface

This manual describes the general operation / maintenance of three-phase, two-winding, hermetically closed, oil-immersed distribution transformers.

Before installing the transformer, read this manual carefully. This manual has been prepared to provide information on assembly, installation, commissioning and regular maintenance of the transformers.

Recommendations and requirements mentioned in this manual must fully comply for warranty retention. During warranty period, a transformer or a part of transformer shall not be opened for repair or internally inspected by a third party.

The transformers are manufactured according to EN / IEC standards:

- EN / IEC 60076-1 Power transformers.
- EN 50588-1 Medium power transformers 50 Hz, with highest voltage for equipment not exceeding 36 kV - Part 1: General requirements.
- IEC 60076-7 Loading guide for oil-immersed power transformers.
- IEC 600296 Transformer oil.
- Other is agreed and confirmed in technical specifications to the order.

During the manufacturing process, the transformer undergoes design changes aimed at improving the product's performance. These changes may not be reflected in this manual.

2. Technical data

Operating conditions of the transformers are as follows:

- altitude above the sea level: up to 1000 m;
- ambient air temperature: from minus 25°C to plus 40°C;
- transformers should install in well-ventilated closed rooms or places where proper cooling conditions are ensured.

Rated frequency is 50 Hz.

Higher voltage

- The transformer can operate continuously at voltage exceeded by no more than 5% of voltage of tap changer position.

Unacceptable operating conditions:

- in the dangerously explosive and aggressive medium (containing gases, vapors, dust of high concentration. etc.);
- at the places subject to vibration and jolting;
- when frequent switchings on-and-off are required.

Technical parameters of transformers are stated on the rating plate and in the Certificate.

Transformers should be loaded in accordance with IEC 60076-7. Loading guide for oil-immersed transformers.

Short-circuit withstand capacity

- Transformers are designed and guaranteed to withstand without any damage all mechanical and thermal effects to short-circuit according to IEC-60076-5 (Power of Short-circuit - 500 MVA, duration of Short-circuit – 2 s)

3. Design and features

The transformer is composed of an active part, tank, cover, bushings, oil, protecting devices and other accessories. Details are mentioned in the dimension drawing, provided with each transformer.

The active part of the transformer consists of core and windings, tap changer.

Core

Transformer's core is made of cold rolled Grain Oriented Electrical Steel (GOES). Both sides of steel sheets are laminated with ceramic insulation. The core construction is optimized for cold-rolled steel properties so that minimum no-load losses and small magnetizing power.

Windings

Windings of the transformer are made of electrolytic copper or aluminum. High voltage windings are multi-layer. Interlayer insulation is made from cable insulating paper and prespan. Low voltage windings are wound with profile wire or foil insulated with diamond dotted paper and prespan.

Tap changer

Tap changer is used to adjust the voltages. Its handle is located on the top tank cover. Tap changer's dial incorporates the perforated ring and locking pins that ensure correct positioning of it after voltage regulation. Switching position of No. 1 is corresponding to the tap with maximum voltage.

Warning! Tap changer can NOT be used when the transformer is energized.

Tank

The transformer is equipped flexible corrugated tank that assures the expansion and contraction of oil due to varying service conditions. The tank with corrugated walls dissipates the internal heat generated during operation of transformer.

The following facilities are in the lower part of the tank:

- drain/sampling valve;
- earthing terminals;
- undercarriage frame with bi-directional rollers.

The undercarriage frame has holes designed for pulling the transformer on short distances on a smooth surface. Moving the transformer by the bars reinforcing corrugated walls of the tank may result in damage to the tank or oil leakage.

The tank is capable to withstand over-pressure of 30 kPa without any permanent deformation. Transformers are provided with a relief valve to remove gases in the event of sudden rise of internal pressure over 35 kPa (0.35 Bar).

Cover

The tank cover is bolted and sealed to it.

On the tank cover are placed:

- two lifting lugs;
- thermometer pocket;
- oil level indicator;
- safety valve;
- earthing terminals;
- high and low voltage bushings.

Insulating Oil

Insulating oil is in conformity with IEC 60296. Transformers are filled with mineral oil without PCB.

Before filling oil is cleaned and dried in achieve to attain required electric strength. The breakdown voltage of this oil is at least 40 kV. For a transformer in operation, the electrical strength must be at least 35 kV. If the measured breakdown voltage is lower, the oil must be regenerated by filtering or another method.

4. Transportation and lifting

Transportation

Transformers can be transported by railway, lorry or other means of transport. During transport, transformers must be securely placed in vertical position and firmly fastened to prevent any displacement. Transformer's undercarriage has small pulling eyes designed for ropes or fastening belts.

Transformers are supplied in a fully assembled state, filled with oil.

Lifting

Transformers should be lifted only by using the lifting bollards provided on the main body for the purpose. All the lifting bollards should be used simultaneously. Should be care to use the correct size of sling for lifting and the lifting angle should not exceed 60°.

5. Commissioning and start-up

Visual Inspection

After the delivery of the transformer it is imperative to perform the following steps:

- visual inspection to determine any possible damage during transportation (cracked bushings, dented tank wall, etc.);
- check the oil level;
- clean all metal parts, removing any rust-preventive grease (protection life is 12 months), especially from the clamps and bolts of the bushings and earth terminals;
- in the event of a minor leak of oil, repair them by tightening the appropriate screws and bolts.

Installation

- each transformer should be installed in a well-ventilated place, free from excessive dust, corrosive fumes etc;
- weight of the transformer must be evenly distributed on all points of the support.

Connecting of the transformer and preparing for start-up

After the Installation of the transformer it is imperative to perform the following steps:

- secure the transformer to prevent any displacement;
- connect earthing cables;
- conduct measurement of insulation resistance of the windings (Megger Test);
- check ratio of transformer in all tap changer positions, connection and phase displacement symbol;
- measure effective LV and HV resistances on each tap;
- put tap changer dial in the position required for normal transformer operation;
- connect cables, bus bars or overhead conductors to bushings;

Tightness conditions will be kept as follows:

- for Insulators bolts

Screw size	M12	M20	M30x2	M42x3	M48x3	M55x3
Torque N*m	15	30	75	110	180	250

- for mechanical parts

Screw size	M8	M10	M12	M14	M16	M18	M20
Torque N*m	20	45	80	125	190	275	385

- measure the earth electrode resistance (earth resistance should be $\leq 5 \Omega$);
- connect leads to signaling and protection devices;
- perform control measurement of insulation of transformer with cables;
- check correctness of choice and connection of transformer protection devices from overvoltage and short-circuit;
- inspect whole transformer with equipment.

Transformer start-up

After the inspection and pre-commissioning tests are successfully completed the transformer must be operated off-load. Before start-up the transformer to the mains, make sure that:

- an inspection of all devices associated with transformer operation has been done;
- apply rated voltage to the HV inlets and leave the transformer in no-load mode for a period to 60 minutes. Only then transformer may be loaded up to the maximum value stated on the rating plate;
- measure LV voltage (between phases and neutral point) before and after loading. Differences between values on different phases should not be over 1%.

Note! If a trip function is activated in any of the protecting devices, the transformer must not be turned on again without the cause of trip activation is determined.

6. Transformer operation and maintenance

Voltage regulation using off-load tap changer

In order to change a high voltage, the next actions should take observing the sequence below:

- de-energize the transformer;
- disconnect all cables leading to HV & LV bushings;
- earth both HV and LV side of the transformer;
- put the tap changer in required position by turning the tap changer dial;
- re-start the transformer.

Maintenance of unused transformers

Should inspect the following:

- not operated transformers should be maintained in the same way as transformers in operation;
- transformer should never be disassembled;
- check the oil level at least every six months;
- carry out a visual inspection at least once a year;
- measure of insulation level HV and LV side;
- provide protection for fragile parts and elements;
- protect all metal terminals with anticorrosive lubricant;

- restrict access of unauthorized persons to the transformer.

Oil sampling is not required for hermetically closed oil-filled transformers.

The oil sample is necessary if an internal damage is suspected of the active part.

To collect a sample use the sampling valve at the bottom of the transformer tank.

Frequency and scope of inspections

Transformers do not require any particular maintenance. However, to guarantee reliable operation, periodic checks (according to native power engineering regulations but at least every 12 months) should be carried out:

- make mark any abnormalities in the sound generated by the transformer;
- de-energize the transformer;
- fix indications of all measuring devices;
- check the current oil level and look at an oil leakage;
- mark the temperature of transformer oil indicated by the thermometer;
- bushings and terminals should be cleaned and their physical status should be properly checked;
- control tightening torques of all electric connections;
- grounding resistance should be checked annually. It must not exceed 5 Ω .
- inspect condition of all connections leading to protection devices;
- examine condition of auxiliary and protection devices.

If a malfunction is detected, it must be corrected immediately.

The minor oil leakage (if the indicated oil level is maintained above minimum) does not cause deterioration of parameters oil in tank. After fixed the leakage there is no need for performing oil control tests.

If there is overheating of transformer, reasons should be detected.

7. Troubleshooting

Following table 1 shows some of the symptoms, possible causes and remedies in case of abnormal situations:

Table 1

TROUBLE	CAUSE	REMEDY
High oil temperature	Over voltage	Change the circuit voltage or transformer connections to avoid over excitation.
	Over current	If possible, reduce load. Heating can be reduced by improving power factor of load. Check parallel circuits for circulating currents, which may be caused by improper ratios or impedances.
	High ambient temperature	Improve ventilation or reduce load.
	Insufficient cooling	Make sure cooling is adequate.
	Low oil level	Top up oil to proper level.
	Short circuited core	Test for exciting current and no-load loss. If high inspect core and repair.
Electrical troubles or winding failure	Lightning, short circuit, overload, oil of low dielectric strength	Usually, when a transformer winding fails, the transformer is automatically disconnected from the circuit by the circuit breaker. Take oil sampling, measure insulation and effective resistance of the windings, inspect active part.

In the event of any damage or disturbances preventing normal transformer operation the transformer must be switched off and an emergency inspection carried out.

8. Documents delivered with the transformer:

- technical parameters specified on the rating plate;
- Certificate;
- operation and maintenance manual;
- dimension drawing;
- manuals for accessories and protection devices.

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