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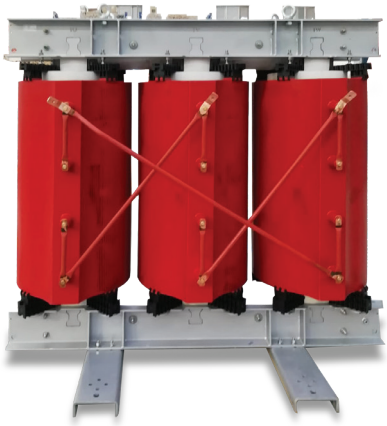
Ulusoy Distribution Transformers Maintenance, Operation, Installation and Instruction Manual



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1. INTRODUCTION

The transformer requires less maintenance compared with other electrical equipments. The degree of maintained and necessary inspection for its operation depends on its capacity, on the importance within electrical system, the place of installation within the system, on the weather conditions and the general operating conditions.

In this part of the manual the operation and maintenance instructions are provided. Our intention is to provide the necessary assistance to the maintenance personnel to facilitate a periodic inspection of the transformer and to indicate the steps that they should follow to effect a more detailed examination of the active part in case that is required.

Read these instructions carefully before proceeding with installation, operation or maintenance of this equipment. To prevent death, serious personal injury or property damage, all information in these instructions should be read and observed. Safe use of this equipment depends on proper installation, operation and maintenance procedures.

2. IMPORTANT SAFETY INFORMATION

Certain information in this manual is marked with the words **DANGER, WARNING** or **CAUTION. DANGER** indicates an imminently hazardous situation that will result in death, serious personnel injury, and property damage if not avoided.

WARNING indicates a potentially hazardous situation that could result in death, serious personnel injury, and property damage if not avoided. **CAUTION** indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate personnel injury and property damage.

Personnel should not attempt to service this equipment until it has been completely de-energized and all high voltage and low voltage bushing terminals have been properly earthed.

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 equipments (such as rubber gloves, safety glasses, protective clothing, hard hats, etc.) and trained in appropriate first aid procedures.

3. TRANSPORTATION

Liquid immersed distribution transformers are shipped completely sealed. Core and coils are assembled in a tank with the insulating liquid covering the coils.

This method of construction preserves the quality of insulation, the cooling and insulating liquid by preventing contamination from external sources.

3.1 TRANSPORTATION BY TRUCK

The transformers must be tightly secured at the top and bottom on the truck. At the bottom by nailing down the base for the rollers or carriage. Fixed rollers should be clamped. The top of the transformer must be tightly secured via the lifting lugs or via special transport clamping lugs. If securing straps are used, make sure they do not pull on the lips or lip reinforcements.

3.2 TRANSPORTATION BY RAILWAY OR SEA

Transformers are usually packed in strong crates, boxes or containers. When packed in crates, the transformer's lifting lugs can be used to lift the entire equipment.

Under no circumstances may moisture be allowed to penetrate into the transformer. For hermetically sealed transformers - both those with gas cushions and those with integral filling – this is not a problem. The liquid cannot come into contact with the surrounding air. In free-breathing transformers (either with or without an expansion tank), air infiltration during transportation and storage must be prevented by one of the following methods. Either placing a gasket in the de-aerator (breather), which must be removed before the transformer is energized, or replacing the silica gel air breather with a blind flange that prevents the infiltration of air. In that case the air breather is supplied separately. Assembly instructions are included with the air breather.

3.3 ACCEPTANCE PROCEDURE

Upon arrival of a transformer and its accessories everything should be sure closely inspected.

The following points should be checked before acceptance:

- Is there any damage on the crate or box?
- Is there any rust or is the paint on the transformer or its accessories damaged?
- Are the transformer tanks or accessories damaged?
- Are there any liquid leakage?
- Are bushings of HV or LV damaged?
- If the liquid level is visible: is it high enough?
- Is the delivery complete?
- Check the number of transformers, the number of boxes of accessories and check that all accessories are fitted or present.
- Check the information on the nameplate.
- Is the paint of tank damaged?

All deviations should be reported immediately to the manufacturer. If no report has been received within one week of the delivery, we shall assume that the delivery arrived complete and in good condition.

4. HANDLING

Please follow the instructions in order to move the transformer.

- Transformer can be moved by means of cylindrical rollers in manual handling as it is shown in the figure 1.
- If crane or lift truck is necessary according to distance and power of transformer, only use lifting lugs on the cover as it is shown in the figure 2 and 3.
- Transformer must never be lifted at the lower side of the cooling fins as it is shown in the figure 4.
- Never use the bushings (high voltage (HV) or low voltage (LV) insulators) to guide the transformer when moving it.
- During the transport or the handling, it is recommended to use only the special lifting eyes and tow attachments. Angle between the laps has to be 60 degrees.
- Use suitable hook and rope which has enough length.
- The length of the ropes (H) must be greater than the distance between lifting lugs (L).

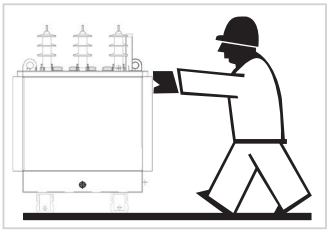

Fig. 1 Manual Handling

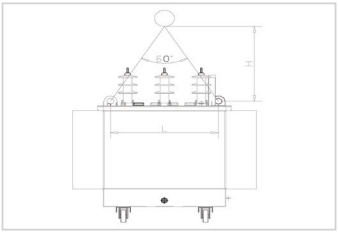

Fig. 2 Lifting Transformer

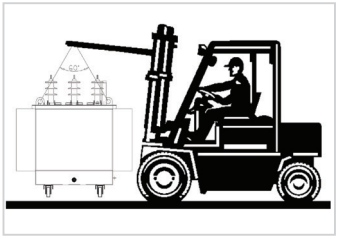

Fig. 3 Handling by means of bridge crane and forklift truck

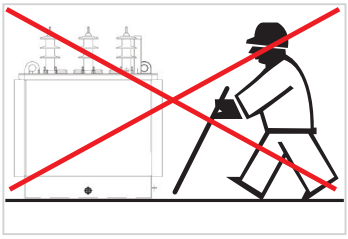

Fig. 4 Wrong handling!

WARNING: The transformer can not be moved by pushing the cooling fins or radiators or tank.

5. STORAGE

It is advisable to locate a transformer, complete with liquids in its permanent location even if it will not be placed in service for some time. It is well to check the paint finish and to repair all damaged painted surfaces. If the transformer is shipped and stored in dry inert gas, the gas pressure should be maintained and periodically tested. If a liquid immersed, indoor-type transformer is stored outdoors it should be thoroughly covered to keep out rain.

A transformer should not be stored or operated in the presence of corrosive vapors or gases, such as chlorine. If it becomes necessary to store accessories for a long period of time, they should be stored in a clean, dry place or the manufacturer should be contacted for explicit instructions on the storage of individual pieces.

WARNING!!! Unless indicated otherwise storage temperature must be between -25C° and +50C°

Monitoring and checking the transformers during storage:

Preferably only fully assembled, liquid immersed transformers can be stored for a extended period of time. The following checks must be carried out during storage:

- Checking of the air breather, if fitted.
- The color of the silica gel must be orange.
- The level of the liquid lock must be checked.
- The transformer must be checked for leaks.
- Check that there is no damage to the paint and that there is no rust.

Storage after taken out of operation; Before the transformer is stored, a full check as described in the “Acceptance procedure” paragraph should occur.

Correct storage is client’s responsibility.

If any defects are established, they should either be remedied immediately or the manufacturer should be informed as quickly as possible.

6. INSTALLATION AND CONNECTION

6.1 INSTALLATION

The installation location of a transformer must be carefully considered. Transformers, as is the case with most electrical equipment, generate a substantial amount of heat during operation. This heat must be removed in order to allow the transformer to maintain its designed maximum temperature limits.

If the transformer is located outdoors, the heat will be removed by natural convection cooling unless surrounding objects restrict the radiator (or corrugated walls) airflow. Indoor installations require adequate ventilation to remove the heat of transformer operation. Inlet ventilation openings should be as low as possible and outlet ventilation openings as high as possible.

- Average temperature over 24 hours must not exceed +30°C and the temperature of the room should not exceed +40°C.
- Care should be taken to prevent restriction of air circulation.
- Adequate space must be maintained between transformers / between transformers and nearby equipment or walls.
- Separation is especially important near the transformer radiators, with a recommended minimum spacing equal to the radiator panel depth.
- In case the altitude of the place of installation higher than 1000m and/or the ambient temperature values are higher than the ones specified above, it is necessary to specify it at the ordering stage since a particular dimensioning of the transformer depends upon these values.
- Do not energize the transformer which do not provide storage control procedures.

6.2 CONNECTION

6.2.1 Electrical and Mechanical Connections

- Decide and choose the cable cross-section according to the system current and voltage.
- Be sure that the surfaces are clean. Dirty surfaces may cause isolation and contact problems.

- Be sure that the cable and busbar terminal connections are not loose. Loose connections may cause extra temperature rise and voltage drop.
- All connections have to be done according to Table 1.

Thread size	M6	M8	M10	M12	M16	M20	M30	M42	M48
Spanner size	10	13	17	19	24	30	46	65	75
A) Bushing insulators Low voltage (LV) DIN 42530				250A		630A	1000A	2000A	3150A
1. Fixing of bushing terminal stud: cork gasket				10-15Nm		25-55Nm	65-150Nm	100-300Nm	150-500Nm
nbr gasket				7-10Nm		17-37Nm	44-100Nm	67-200Nm	100-334Nm
2. Connection between nuts				15-20Nm		70-100Nm	250-350Nm		
3. Fixing of flag connector to terminal stud (bolt and nut in stainless steel)			25-35Nm	40-60Nm					
4. Bolts to flag connector surface			25-35Nm	40-60Nm	100-150Nm				
High Voltage (HV) DIN 42531									
1. Fixing of top of terminal stud (terminal stud and nuts in brass)				10-15Nm					
2. Connection to terminal stud (terminal stud and nuts in brass)				15-20Nm					
3. Fixing of base (stud and nut in stainless steel)									
cork gasket			10-20Nm	20-35Nm					
nbr gasket			10-15Nm	15-25Nm					
Plug-in bushing									
cork gasket			10-20Nm						
nbr gasket			10-15Nm						
B) LV connecting busbar									
Interconnection (pin and nut in 8.8 steel)			45-60Nm	65-85Nm	95-130Nm				
C) Cover / frame									
Bolt and nut in stainless steel (pitch = 60mm) = cork		20-25Nm		40-60Nm					
gasket (pitch = 90mm) = nbr gasket		20-25Nm		40-60Nm					
D) Busbar bushings									
Fixing on cover		8-15Nm							
Top piece onto bottom piece	5,4-6Nm								

Table 1: Torque values of connection of live conductors

- Connection cables and busbars may cause seals or cracks in the bushings even if there is not any tensile force. That's why flexible connection is recommended in all cases.
- Have to adjust alarm and trip relay connection of protection equipment on the transformer. While making the connection, consider connection schema inside of terminal box.
- Thermometer switches should be checked and adjusted to alarm and trip values. Recommended temperature values; Alarm: 85°C, Trip: 90°C
- Tap changer level should be chosen according to system voltage based upon rating plate value. Tap changer level must be adjusted when transformer is de-energized. (If tap changer is not requested on load.)
- Bushing arcing horns are scaled in factory according to the standards. If any defections are detected in gaps, please scale them according to Table 2.

Rated Voltage			Arcing Horn Gap	Phase to Phase	Phase to Earth
0	< Un ≤	3,6	-	50	65
3,6	< Un ≤	7,2	55	100	105
7,2	< Un ≤	12	86	110	115
12	< Un ≤	17,5	110	190	195
17,5	< Un ≤	24	155	210	215
24	< Un ≤	36	220	280	325

Table 2: Outdoor Electrical Clearance

* Un: HV side voltage of rated level

** All clearances are in mm.

*** Electrical clearances are given for ≤1000m. After 1000m till 3000m each 100m distance must be increase %1,25 .

- The transformers should be fastened from the skids (NPU steels) after they are placed on the foundation.

6.2.2 Earthing Connection

- The installation must be carried out according to the standards in force, applicable laws, and the present instructions. The following points must be taken into consideration when the installation is carried out.
- Connect the earthing conductors to the relative earth points on the metallic parts of the transformer and cable boxes.
- Connections should be made strictly with suitable conductors.
- Earth resistance should be ≤ 5 Ω.

6.3 START UP

- Before start up, satisfy of conditions of 6.2.1 and 6.2.2
- Make sure that all equipment, except transformer, are adjusted and chosen properly according to the maximum value of voltage or current.
- All electrical connections must be checked by authorized personnel.
- Safety zone must be allocated while energizing transformer and all living creatures must be taken out of zone.
- First energizing of the transformer must be operated off-load. After inspecting the usual conditions of noise level, temperature and oil level; the transformer would be loaded.

7. OPERATING AND MAINTENANCE

Transformers do not require any particular maintenance. However, in order to use for longer life and get better efficiency, the following checks should be made periodically.

- Liquid level and liquid leakage should be observed periodically. In case any decrease in liquid level,
  - If transformer is conservator type; refined oil with the same specifications should be added. Liquid leakage must be prevented with proper procedure.
  - If the transformer is hermetically sealed, the manufacturer should be informed as soon as possible.
- Dehydrating breather should be checked; in case of malfunctioning, it must be replaced (for conservator type transformers).
- Buchholz relay should be checked periodically. If there is gas accumulation, it must be released after the reason is detected. Functions of relay should be controlled annually.
- Liquid temperature should be checked through thermometer; if there is overheating, reasons should be detected.
- Grounding resistance should be checked annually. (It must not exceed 5 Ω.)
- Maintenance and inspections should be carried on while transformer is de-energized.
- Bushings always should be cleaned and their physical status should be properly checked.
- In case of breaks and cracks in bushings, please contact with the manufacturer for replacement. Bushing should be stocked in vertical position and dry conditions.

- A pressure relief device (T-10) must never be painted. Painting can cause adhesion of rotary rod and string pull, which can cause malfunctioning of pressure relief device. In case of any rise of pressure, tank can be seriously damaged.
- Annually, the transformer and functioning of accessories should be deeply inspected. Inspection should be started from periodically recorded temperature and pressure information. If there is no change in temperature and pressure values (even due to seasonal temperature and load), malfunctioning of accessories or misreporting must be suspected.
- For gasket replacing due to stiffening an aging, get in contact with the manufacturer.

All periodical controls are listed as a table below.

PERIOD		CHECKED	OBSERVATION
HERMETIC	CONSERVATOR		
Weekly	Weekly	Liquid Level	Level Checking
x	Monthly	Dehydrating Breather	Silica Gel Colour
Annually	x	Hermetic Protection Relay	Gas Generation
x	Annually	Buchholz Relay	Gas Generation
Annually	Annually	Gaskets, Radiators/ Corrugated Walls	Loosening and Liquid Leakage
Every 3-5 Years	Every 3-5 Years	Cable Box	Physical Situation and Connections
Once a Month	Once a Month	Bushing	Damage Failure, Cleaning and Liquid Leakage
Annually	Annually	Earthing	Connection and Resistance
Every 6 Months	Every 6 Months	Terminal Connection	Oxidation and Loosening
Every 3-5 Years	Every 3-5 Years	Requirement of Painting	General View
Annually	Annually	Thermometer	Switch on
x	Every 3-5 Years	Conservation Tank	Liquid Leakage
Every 2 Years	Annually	Liquid	Liquid Dielectric Test

Table 3: Periodical Check

Test Name	Method	Unit	New Liquid Sample Desired Value	New Liquid Filling Transformer Liquid Sample Desired Value	Liquid Sample From Operating Transformer		
					Proper	Separation	Changing
Breakdown Voltage	VDE 370	kV	Min. 50	Min. 50	≥ 40	< 40	
Colour Number	ASTM D1500	Numerical	Max. 0.5	Max. 1	< 5		≥ 5
Water Content	ASTM D 1533	Ppm	Max. 30	Max. 20	< 20	≥ 20 - < 50	≥ 50
Acidity	ASTM D 664-974	mgKOH/g	Max. 0.025	Max. 0.025	< 0.4	>0.4 - < 0.5	≥ 0.5
Interior Surface Tension	ASTM D 971	dyne/cm	Min. 40	Min. 40	≥ 21	≥ 17 - < 21	< 17
Loosing Factor (25°C)	ASTM D 924	%	Max. 0.05	Max. 0.1			
Loosing Factor (100°C)	ASTM D 924	%	Max. 0.30	Max. 1	≤ 1.5	> 1.5 - ≤ 3	> 3

Table 4: Transformer Liquid Test Results Assessment -1

Test Name	Method	Unit	New Liquid Sample Desired Value	New Liquid Filling Transformer Liquid Sample Desired Value	Liquid Sample From Operating Transformer	
					Proper	Must Be Removed
Pcb Analysis	ASTM D 4059	ppm	NA	NA	< 50	> 50

Table 5: Transformer Liquid Test Results Assessment -2

Test Name	Method	Unit	New Liquid Sample Desired Value	New Liquid Filling Transformer Liquid Sample Desired Value	Liquid Sample From Operating Transformer	
					Proper	Must Be Removed
Anti Oxidation Additive (Dbpc)	ASTM D 4768	%	0.2 – 0.3	0.2 – 0.3	0.2 – 0.3	< 0.2

Table 6: Transformer Liquid Test Results Assessment -3

Test Name	Method	Unit	New Liquid Sample Desired Value
Density	ASTM D 1298	gr/cm³	0.865 – 0.910

Table 7: Transformer Liquid Test Results Assessment -4

8. ACCESSORIES

8.1 STANDARD COMPONENTS AND ACCESSORIES

- Rating plate
- HV porcelain bushing
- LV porcelain bushing
- Off-load tap-changer
- Earthing terminals
- Tow attachment
- Lifting eyes
- Rollers (>400 kVA)
- Thermometer pocket
- Drain valve
- Arcing horns on HV porcelain bushing, (for transformer without HV cable box)
- Air dehydrating breathers, (for breathing transformer)
- Liquid level indicator
- Pressure relief vent, (for hermetically sealed transformer)

8.2 OPTIONAL COMPONENTS AND ACCESSORIES

- Plug-in HV terminals
- Thermometer, to install on the thermometer pocket
- Multifunctional protection relay, (for hermetically sealed transformers)
- Buchholz relay (for breathing transformer)
- Pressure relief device with contact
- PT100 thermo-resistance (to install in the thermometer pocket)
- HV or LV cable boxes
- Dial type thermometer
- Liquid level indicator with contacts, (for breathing transformers)
- Current transformer
- Winding temperature indicator
- With and without contact thermometer

9. STANDARDS

For more information on transformers in general, you can have a look at the following IEC and CENELEC standards:

IEC 60076	:	Power transformers
IEC 60076-1	:	General
IEC 60076-2	:	Temperature rise
IEC 60076-3	:	Insulation levels, dielectric tests and external clearances in air
IEC 60076-5	:	Ability to withstand short-circuit
IEC 60076-10	:	Determination of sound levels (used to be IEC 551)
IEC 60296	:	Specification for unused mineral insulating oils for transformers and switchgear
IEC 60422	:	Supervision and maintenance guide for mineral insulating liquids in electrical equipment.
IEC 60475	:	Method of sampling liquid dielectrics
IEC 60567	:	Guide for the sampling of gases and of liquid from liquid-filled electrical equipment and for the analysis of free and dissolved gases
IEC 60599	:	Mineral liquid-impregnated electrical equipment in service - Guide to the interpretation of dissolved and free gasses analysis
EN 50180	:	Bushings above 1 kV up to 36 kV and from 250 A to 3150 A for liquid-filled transformers
HD 398	:	Identical to IEC 60076
HD 428	:	Three-phase liquid immersed distribution transformers 50 Hz, from 50 to 2500 kVA with highest voltage for equipment not exceeding 36 kV

10. FINAL REMARK

In this manual, the main issues and technical issues of the transformers are defined. Please keep in mind that this manual is written for qualified / experienced users only. For further information and technical support, please contact us.

ANNEX 1: PRODUCT QUALITY FOLLOW-UP FORM

Type	:	Acceptance Date	:
Order No.	:		
Serial No.	:	Delivery Date	:
Rated Power (MVA)	:		
Rated Voltage (kV)	:	Commissioning Date	:
Special Remarks	:		

Dear Customer,
Your confidence that is the consequence of harmony of our products and service constitutes the basis of our lasting partnership. Please fill up the questionnaire of the Product Quality Follow-up Form for enabling us to provide you a better and comprehensive service.
Yours Respectfully

1. Did you observe any damage on the transformer after transport?
2. Did you have any problems during the connection of transformer to the network?
3. Did you have any problems in commissioning?
4. Does the transformer work at full load?
5. Do you have any problems about the protective devices of the transformer?
6. Do you have any problem about the surface protection quality (paint) of the transformer?
7. Is there any liquid leakage on the transformer? (Invalid for dry type distribution transformers)
8. Is there any conspicuous point at which you are not satisfied and the other points that you want us to be improved at production of the transformer in the future?
9. Are you satisfied about the performance of the transformer generally?
10. Is it convenient for you to send by filling up the "Control Reporting Forms" concerning periodical maintenance section of the Operational Instructions Manual in a continuous manner?
11. Is there any other point that you want to mention additionally?

Authorized person that filled this form:

Name	:	Date	:
Occupation	:	Signature	:
Company	:		

Please send this form just after commissioning and each following year to the transformer factory address.

Eaton's mission is to improve the quality of life and the environment through the use of power management technologies and services. We provide sustainable solutions that help our customers effectively manage electrical, hydraulic, and mechanical power - more safely, more efficiently, and more reliably.

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