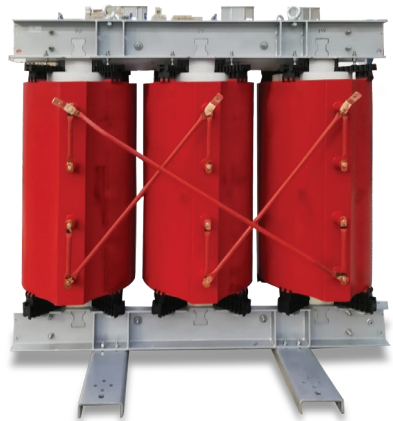


# Ulusoy Distribution Transformers Maintenance, Operation, Installation and Instruction Manual



# 1. INTRODUCTION

The transformer requires less care 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 operating instructions and maintenance are supplied. 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 which, if not avoided, will result in death, serious personnel injury and property damage.

**WARNING** indicates a potentially hazardous situation which, if not avoided, could result in death, serious personnel injury, and property damage. **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

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. For transformers with an expansion tank the infiltration of air during transportation and storage is prevented by: 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:

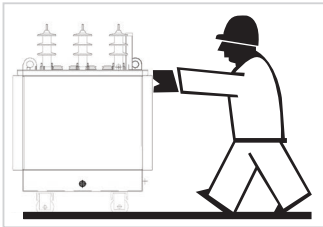
- Is there any damage on the crate or box?
- Is there any rust or is the paint on the transformer or its accessories damaged?
- Are the transformer tanks or accessories damaged?
- Are there any oil leakage?
- Are bushings of H.V or L.V damaged?
- If the oil level is visible: is it high enough?
- Is the 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.

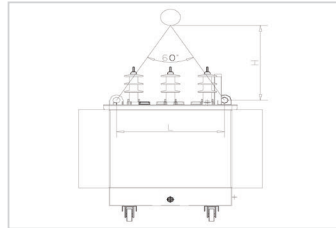
## 4. HANDLING

Please follow the instructions in order to move the transformer.

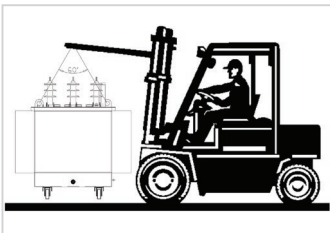
- Transformer can be moved by means of cylindrical rollers in manual handling as it is shown in the figure 1.
- If crane or lift truck is necessary according to distance and power of transformer, only use lifting lugs on the cover as it is shown in the figure 2 and 3.
- Transformer must never be lifted at the lower side of the cooler 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 lugs 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).



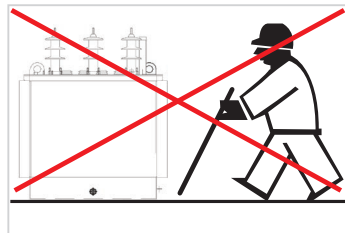
**Fig. 1** Manual Handling



**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 an oil-filled, 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-filled transformers can be stored for a long 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 oil 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 a transformer is located outdoors, the heat will be removed by natural convection cooling unless the radiator (or corrugated walls) air flow is restricted by surrounding objects. 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 height 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
<b>A) Bushing insulators</b>				250A		630A	1000A	2000A	3150A
<b>Low voltage (LV) DIN 42530</b>									
1. Fixing of bushing terminal stud: cork gasket nbr gasket				10-15Nm 7-10Nm		25-55Nm 17-37Nm	65-150Nm 44-100Nm	100-300Nm 67-200Nm	150-500Nm 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				
<b>High Voltage (HV) DIN 42531</b>									
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 nbr gasket			10-20Nm 10-15Nm	20-35Nm 15-25Nm					
<b>Plug-in bushing</b>									
cork gasket nbr gasket			10-20Nm 10-15Nm						
<b>B) LV connecting busbar</b>									
Interconnection (pin and nut in 8.8 steel)			45-60Nm	65-85Nm	95-130Nm				
<b>C) Cover / frame</b>									
Bolt and nut in stainless steel (pitch = 60mm) = cork gasket (pitch = 90mm) = nbr gasket		20-25Nm 20-25Nm		40-60Nm 40-60Nm					
<b>D) Busbar bushings</b>									
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 be adjust alarm and trip relay connection of protection equipment which are on transformer. While doing 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 choosen 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 standards. If any defections detected in gaps, please scale them according to Table 2.

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

**Table 2:** Outdoor Electrical Clearance

- \*  $U_n$ : H.V side voltage of rated level
- \*\* All clearances are in mm.
- \*\*\* Electrical clearances are given for  $\leq 1000m$ . After 1000m till 3000m each 100m distance must be increase %1,25 .
- Transformers must fasten from where they stay skid of transformer (NPU steel).

### 6.2.2 Earthing Connection

- The installation must be carried out according to the standards in force, to the applicable laws and to 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 done strictly with suitable conductors.
- Earth resistance should be  $\leq 5 \Omega$ .

## 6.3 START UP

- Before start up, satisfy of conditions of 6.2.1 and 6.2.2
- Make sure that all equipments, except transformer, are adjusted max value of voltage or current and choosen properly.
- All electrical connection 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, to guarantee good operation, a few periodic checks should be carried out as follows.

- Oil level and oil leakage should be observed periodically. In case any decrease in oil level,
  - If transformer is conservator type; refined oil with the same specifications should be added.Oil leakage must be prevented with proper procedure.
  - If 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.
- Oil temperature should be checked through thermometer; if there is overheating, reasons should be detected.
- Grounding resistance should be checked annually. (It must not exceed  $5\ \Omega$ .)
- 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.

- 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, 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	Oil 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 Oil 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 Oil 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	Oil Leakage
Every 2 Years	Annually	Oil	Oil Dielectric Test

Table 3: Periodical Check

Test Name	Method	Unit	New Oil Sample Desired Value	New Oil Filling Transformer Oil Sample Desired Value	Oil 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 Oil Test Results Assessment -1

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

Table 5: Transformer Oil Test Results Assessment -2

Test Name	Method	Unit	New Oil Sample Desired Value	New Oil Filling Transformer Oil Sample Desired Value	Oil Sample From Operating Transformer	
					Proper	Must Be Removed
Anti Oxidation Additive (Dbpc)	ASTMD 4768	%	0.2 - 0.3	0.2 - 0.3	0.2 - 0.3	< 0.2

Table 6: Transformer Oil Test Results Assessment -3

Test Name	Method	Unit	New Oil Sample Desired Value
Density	ASTM D 1298	gr/cm <sup>3</sup>	0.865 - 0.910

Table 7: Transformer Oil 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)
- Oil 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
- Oil 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:

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

## 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	:														
<p>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</p>															
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 oil 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?															
<p>Authorized person that filled this form:</p> <table border="0"> <tr> <td>Name</td> <td>:</td> <td>Date</td> <td>:</td> </tr> <tr> <td>Occupation</td> <td>:</td> <td>Signature</td> <td>:</td> </tr> <tr> <td>Company</td> <td>:</td> <td></td> <td></td> </tr> </table>				Name	:	Date	:	Occupation	:	Signature	:	Company	:		
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.

Eaton's 2019 revenues were \$21.4 billion, and we sell products to customers in more than 175 countries. We have approximately 95,000 employees.

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**Ulusoy Elektrik Imalat Taahhut ve Ticaret A.S.**

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