Huawan Power

Huawan liquid immersed distribution transformers

Maintenance, operation, installation and instruction manual

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1. Introduction

Compared with other electrical equipment, distribution transformers generally require limited routine maintenance. The scope and frequency of inspection and maintenance depend on factors such as transformer rating, its importance within the power system, installation location, environmental conditions and actual operating conditions.

This manual provides general recommendations for the operation and maintenance of oil-immersed distribution transformers manufactured by Huawan. The purpose of this document is to assist operating and maintenance personnel in carrying out periodic inspections and to provide guidance for more detailed examination procedures when necessary, in order to ensure safe, reliable and long-term operation of the transformer.

Before installation, energisation, operation or maintenance of the transformer, this manual shall be read and fully understood by qualified personnel. Proper installation, operation and maintenance in accordance with the applicable standards, project requirements and this manual are essential to prevent personal injury, equipment damage or system failure.

2. Important Safety Information

This manual contains important safety information related to the installation, operation and maintenance of oil-immersed distribution transformers manufactured by Huawan. All safety instructions shall be strictly observed to prevent personal injury, equipment damage or system failure.

Only qualified personnel are permitted to install, operate or maintain this equipment. Qualified personnel are those who have received appropriate technical training in high-voltage equipment, are familiar with relevant safety procedures, and are properly equipped with personal protective equipment (PPE) such as insulating gloves, safety glasses, protective clothing and helmets.

Before performing any installation, inspection or maintenance work, the transformer shall be completely de-energized. All high-voltage and low-voltage terminals shall be properly earthed in accordance with applicable safety regulations. Failure to follow these precautions may result in serious injury or equipment damage.

3. Transportation

Oil-immersed distribution transformers are normally shipped in a fully sealed condition. The active part (core and windings) is assembled inside the tank and completely covered by insulating liquid to ensure insulation integrity and moisture protection during transportation.

During transportation and handling, the external condition of the transformer shall be inspected periodically, including the tank surface, fittings and sealing points. Any abnormal condition such as oil leakage, mechanical damage or unexpected change in internal pressure shall be reported and addressed immediately.

For sealed or gas-cushioned transformer designs, the internal pressure may vary slightly due to ambient temperature changes. Under normal conditions, pressure variation is gradual. If the internal pressure drops below the specified range, it shall be adjusted in accordance with the manufacturer’s technical requirements. Typical recommended internal pressure for sealed oil-immersed distribution transformers is 10 kPa to 20 kPa (gauge pressure), unless otherwise specified.

This method of construction and transportation effectively preserves the quality of the insulation system and insulating liquid by preventing contamination from moisture, dust and other external sources.

3.1 Road Transportation

During road transportation, the transformer shall be securely fixed on the transport vehicle to prevent any movement, impact or overturning.

The base of the transformer shall be properly supported and fixed to the vehicle platform using suitable blocking or fastening devices. If rollers or transport skids are used, they shall be firmly restrained to avoid displacement during transport.

The upper part of the transformer shall be secured using the designated lifting lugs or approved transport clamping points. When lashing straps are applied, care shall be taken to ensure that they do not exert force on the tank edges, stiffeners or other non-load-bearing parts.

3.2 Transportation by Railway or Sea

For railway or sea transportation, transformers are normally packed in strong wooden crates, protective frames or containers in accordance with the selected transport method. When packed in crates, the designated lifting lugs may be used for handling the transformer as a complete unit.

Moisture ingress into the transformer must be strictly avoided during transportation and storage.

For hermetically sealed transformers, including designs with gas cushion or fully sealed oil systems, the insulating liquid is isolated from ambient air and no special measures are generally required during transport.

For free-breathing transformers, with or without a conservator, air ingress during transportation and storage shall be prevented by one of the following methods:

Installing a temporary sealing gasket or blocking device in the breather connection, which must be removed before energisation; or

Replacing the silica gel air breather with a blind flange to prevent air entry. In this case, the air breather is supplied separately and shall be installed on site in accordance with the provided instructions.

3.3 Customer Checklist After Delivery

Upon receipt of the transformer and its accessories, a thorough inspection shall be carried out before acceptance.

The following items shall be checked:
Condition of the transport crate, box or packaging;
Presence of corrosion or damage to paint on the transformer or accessories;

Mechanical damage to the tank or accessories;
Any signs of oil leakage;
Condition of high-voltage and low-voltage bushings;
Visible oil level, where applicable;
Completeness of delivery, including transformer units and accessory boxes;
Consistency of quantities with the delivery documents;
Verification of nameplate data.
Any abnormality or deviation shall be recorded and reported to the manufacturer without delay. Timely inspection and reporting help ensure proper handling of transport-related issues and facilitate corrective actions when necessary.

4. Handling

The transformer shall be handled strictly in accordance with the instructions below to avoid mechanical damage and ensure safe transportation and positioning.

Manual handling is permitted for short-distance movement by using suitable cylindrical rollers placed under the transformer base, as illustrated in Figure 1. The rollers shall be aligned properly and the transformer shall be kept stable during movement.

When lifting by crane or handling by forklift truck is required, only the designated lifting lugs provided on the transformer cover shall be used, as shown in Figures 2 and 3. Lifting points are designed to withstand the full weight of the transformer and shall not be substituted by any other structural parts.

The transformer shall never be lifted, pushed or supported by the cooling fins, radiators or tank walls, as illustrated in Figure 4, as this may cause permanent mechanical deformation or oil leakage.

High-voltage (HV) and low-voltage (LV) bushings shall not be used for guiding, pulling or lifting the transformer during handling operations.

During lifting operations, only approved lifting eyes and towing attachments shall be used. The angle between the lifting slings shall not exceed 60 degrees to avoid excessive mechanical stress. Suitable hooks and lifting slings with adequate load capacity and sufficient length shall be selected.

The sling length (H) shall be greater than the distance between the lifting lugs (L) to ensure proper lifting geometry and stability during hoisting.

Figure 1: Manual handling

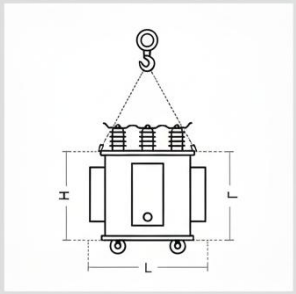

Figure 2: Lifting Transformer

Figure 3: Handling by means if bridge crane and forftlk truck

Figure 4: Wrong handling!

⚠ WARNING

THE TRANSFORMER CAN NOT BE MOVED BY PUSHING THE COOLING FINS OR RADIATORS OR TANK.

5. Storage

Whenever possible, a liquid-immersed transformer should be placed at its final installation location even if it will not be energized immediately. This helps to reduce unnecessary handling and the risk of mechanical damage. The condition of the paint coating shall be inspected and any damaged painted surfaces shall be repaired to prevent corrosion.

If the transformer is shipped and stored under dry inert gas, the internal gas pressure shall be maintained within the specified range and checked periodically during the storage period.

If a liquid-immersed, indoor-type transformer is temporarily stored outdoors, it shall be adequately protected with a weatherproof cover to prevent rain, moisture and direct exposure to the environment.

Transformers shall not be stored or operated in environments containing corrosive vapors or gases, such as chlorine or other chemical agents. Accessories stored separately for an extended period shall be kept in a clean and dry location. For long-term storage of specific components, the manufacturer may be consulted for additional guidance.

⚠ WARNING
UNLESS INDICATED OTHERWISE STORAGE TEMPERATURE MUST BE BETWEEN -20C° AND +40 C°

Monitoring During Storage

As a general rule, only fully assembled liquid-immersed transformers are suitable for long-term storage. During the storage period, the following inspections shall be carried out at regular intervals:

- Inspection of the air breather, if applicable;
- Verification that the silica gel desiccant remains dry and shows the correct color indication;
- Checking of the oil level or liquid lock, where applicable;
- Inspection for any signs of oil leakage;
- Inspection of painted surfaces to ensure there is no mechanical damage or corrosion.
- If a transformer is taken out of service and stored, a complete inspection shall be performed in accordance with the acceptance inspection procedures before storage.
- Any abnormal condition identified during storage shall be corrected promptly or reported to the manufacturer without delay in order to prevent deterioration of the equipment condition.

6. Installation and Connection

6.1 Installation

The installation location of the transformer shall be carefully selected. During operation, transformers generate heat that must be dissipated in order to maintain the designed temperature limits.

For outdoor installations, heat is normally dissipated by natural air circulation, provided that airflow around the radiators or corrugated tank walls is not obstructed. For indoor installations, adequate ventilation shall be provided to ensure effective heat removal.

Ventilation air inlets should be located as low as practicable, while air outlets should be positioned as high as possible to promote natural convection.

The following conditions shall be observed:

The average ambient temperature over 24 hours shall not exceed +30 °C;

The maximum ambient temperature shall not exceed +40 °C;

Air circulation around the transformer shall not be restricted;

Adequate clearance shall be maintained between transformers and between transformers and surrounding equipment or walls;

Particular attention shall be paid to the radiator area, with a recommended minimum clearance equal to the depth of the radiator panels.

If the installation altitude exceeds 1000 m and/or the ambient temperature exceeds the values specified above, these conditions shall be specified at the ordering stage, as special design considerations may be required.

A transformer shall not be energized unless the specified storage and pre-installation inspection procedures have been properly completed.

6.2 Connection

6.2.1 Electrical and Mechanical Connections

The cross-section of cables and busbars shall be selected according to the system voltage and rated current;

All contact surfaces shall be clean and free from contamination to ensure proper electrical contact;

Cable lugs and busbar connections shall be securely tightened. Loose connections may cause excessive temperature rise and voltage drop;

All electrical and mechanical connections shall be made in accordance with the specified tightening torque values and applicable technical table 1.

Table 1. Torque values of connection of live conductors

Category	Description / Component	M6	M8	M10	M12	M16	M20	M30	M42	M48
General	Spanner Size (mm)	10	13	17	19	24	30	46	65	75
A) LV Bushings	Current Rating (Amps)	-	-	-	250A	630A	1000A	2000A	3150A	-
(DIN 42530)	1. Fixing stud (Cork gasket)	-	-	-	10-15	25-55	65-150	100-300	150-500	-
	1. Fixing stud (NBR gasket)	-	-	-	10	17-37	44-100	67-200	100-334	-
	2. Connection between nuts	-	-	-	15-20	-	70-100	-	250-350	-
	3. Flag to stud (Stainless)	-	-	-	-	40	55-60	-	-	-
	4. Bolts to flag surface	-	-	-	-	40	55-60	100-150	-	-
A) HV Bushings	1. Top of terminal stud (Brass)	-	-	-	10-15	-	-	-	-	-
(DIN 42531)	2. Conn. to terminal stud (Brass)	-	-	-	15-20	-	-	-	-	-
	3. Base fixing (Cork gasket)	-	-	-	-	15-20	25-35	-	-	-
	3. Base fixing (NBR gasket)	-	-	-	-	10-15	20-25	-	-	-
A) Plug-in	Cork gasket	-	-	-	15-20	-	-	-	-	-
	NBR gasket	-	-	-	20-25	-	-	-	-	-
B) LV Busbar	Interconnection (Steel 8.8)	-	-	-	45-60	65-85	95-130	-	-	-
C) Cover/Frame	Cork (p=60) / NBR (p=90)	-	-	-	30-35	75-85	-	-	-	-
D) Busbar Bush.	Fixing on cover	-	-	8-15	-	-	-	-	-	-
	Top piece to bottom piece	5.4-6	-	-	-	-	-	-	-	-

- 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.

Table 2. Outdoor electrical clearance

Rated Voltage Un (kV)	Phase to Earth (mm)	Phase to Phase (mm)	Horn Gap (mm)
0 < U_n ≤ 3.6	50	65	-
3.6 < U_n ≤ 7.2	55	100	105
7.2 < U_n ≤ 12	86	110	115
12 < U_n ≤ 17.5	110	190	195
17.5 < U_n ≤ 24	155	210	215
24 < U_n ≤ 36	220	280	325

* Un: HV side voltage of rated level
** All clearances are in mm.
*** Electrical clearances are given for ≤1000 m. After 1000 m till 3000 m each 100 m 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 earthing system shall be installed in accordance with the applicable national standards, local regulations, and the instructions provided in this manual. The following requirements shall be observed during installation:

Earthing conductors shall be securely connected to the designated earthing terminals provided on the transformer tank, metallic structural parts, and cable boxes.

All earthing connections shall be made using suitable conductors with adequate cross-sectional area and mechanical strength.

All connections shall be firm, corrosion-resistant, and electrically continuous.

The grounding resistance of the installation shall not exceed 5 Ω.

Start-Up (Commissioning)

Before energizing the transformer, the following conditions shall be satisfied:

All requirements specified in Sections 6.2.1 Electrical and Mechanical Connections and 6.2.2 Earthing Connection shall be fully complied with.

All associated equipment, excluding the transformer itself, shall be correctly selected, adjusted, and rated for the maximum system voltage and current.

All electrical connections shall be inspected and verified by authorized and qualified personnel.

A safety zone shall be established during energization, and all unauthorized personnel, animals, and objects shall be kept outside the energized area.

Initial energization of the transformer shall be performed under no-load conditions. After confirming normal operating conditions such as noise level, oil temperature, and oil level, the transformer may then be gradually loaded.

Oil-immersed transformers shall not be energized when the oil temperature is below –25 °C.

7. Operation and Maintenance

Under normal operating conditions, oil-immersed transformers require minimal maintenance. However, to ensure long service life and reliable performance, the following inspections and maintenance activities shall be carried out periodically.

Routine Checks

The oil level and any signs of oil leakage shall be monitored regularly.

For conservator-type transformers, refined insulating oil with identical specifications shall be added if the oil level decreases.

Any oil leakage shall be addressed promptly using appropriate corrective procedures.

For hermetically sealed transformers, the manufacturer shall be informed immediately in the event of oil leakage or abnormal conditions.

The dehydrating breather (for conservator-type transformers) shall be inspected periodically and replaced if malfunctioning.

The Buchholz relay shall be checked regularly. If gas accumulation is detected, the gas shall be released only after identifying the cause. Functional tests of the relay shall be performed at least once per year.

Oil temperature shall be monitored via the temperature indicator. In case of abnormal temperature rise, the cause shall be investigated without delay.

Grounding resistance shall be measured annually and shall not exceed 5 Ω.

Maintenance and Inspection Requirements

All maintenance and inspection activities shall be carried out only when the transformer is completely de-energized.

High-voltage and low-voltage bushings shall be kept clean and inspected regularly for cracks, damage, or contamination.

If any damage is observed on bushings, the manufacturer shall be contacted for replacement. Spare bushings shall be stored in a vertical position in a dry environment.

The pressure relief device shall never be painted. Painting may impair its operation and prevent proper pressure release, which may result in serious damage to the transformer tank.
At least once per year, a comprehensive inspection of the transformer and all accessories shall be conducted. This inspection shall include a review of recorded temperature and pressure data.
If temperature or pressure readings show no variation over time (including seasonal and load-related changes), malfunction or incorrect indication of accessories shall be suspected and investigated.
For gasket replacement due to aging or loss of elasticity, the manufacturer shall be consulted prior to replacement.

All periodical controls are listed as a table below.

Table 3. Periodical check

Checked	Observation	Period: Hermetic	Period: Conservator
Liquid level	Level checking	Monthly	Monthly
Dehydrating breather	Silica gel colour	x	Monthly
Hermetic protection relay	Gas generation	Annually	x
Buchholz relay	Gas generation	x	Annually
Gaskets, radiators / Corrugated walls	Loosening and liquid leakage	Annually	Annually
Cable box	Physical situation and connections	Every 3-5 years	Every 3-5 years
Bushing	Damage failure, cleaning and liquid leakage	Once a month	Once a month
Earthing	Connection and resistance	Annually	Annually
Terminal connection	Oxidation and loosening	Annually	Annually
Requirement of painting	General view	Annually	Annually
Thermometer	Switch on	Annually	Annually
Conservation tank	Liquid leakage	x	Annually
Liquid	Liquid dielectric test	Every 3 years	Annually

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	Operating: Proper	Operating: Separation	Operating: 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 5. Transformer liquid test results assessment - 2

liquid sample from operating transformer

Test Name	Method	Unit	New liquid sample desired value	New liquid filling transformer liquid sample desired value	Operating: Proper	Operating: Must be removed
Pcb Analysis	ASTM D 4059	ppm	NA	NA	< 50	> 50

Table 6. Transformer liquid test results assessment - 3

Test Name	Method	Unit	New Liquid Sample Desired Value	New Liquid Filling Transformer Liquid Sample Desired Value	Operating: Proper	Operating: 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 7. Transformer liquid test results assessment - 4

Test Name	Method	Unit	New liquid sample desired value
Density	ASTM D 1298	gr/cm^3	0.865 - 0.910

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 IEEE standards:

Standards	Description
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