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# Installation, Operation and Maintenance Manual

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## General operating principles

The transformers supplied are oil filled three phase distribution transformers having a Delta connected primary winding and a Star connected secondary winding.

Overloads are permitted in accordance with IEC 354

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# 1. Transportation and reception

The transformers are despatched ready for installation following a thorough final inspection at the works before loading on the delivery vehicle. This means that the transformer is complete with insulating oil and ready for operation following cabling up and pre-commissioning tests and inspections.

## 1.1 Transportation by truck

The transformers are firmly secured by blocking the roller wheels, if fitted, and by securing to the vehicle by using steel wire, ropes or straps fastened to the lifting lugs or, where provided, the special transport lugs at the top of the tank. No pressure must be put on the radiator fins.

## 1.2 Reception procedure

Upon receipt of a transformer a thorough inspection should be carried out. In particular the following points should be checked.

Are there any signs of impact damage such as damaged packing materials, scratched paint or rusted bare metal?

- Are the fittings all present and intact?
- Is the oil liquid level correct?
- Are there any signs of leakage or damp spots indicating oil?
- Is the nameplate information correct?

Any defects should be reported immediately to Pauwels International NV. If no report is received within one week from delivery we assume that the transformer has arrived in good condition.

In the event of a problem after delivery transportation insurance requires that the following procedure is observed:

Immediately notify the Transport Company delivering the transformer. Take any reasonable steps to limit the damage and prevent further damage.

## 1.3 Moving the transformer

The transformer is provided with certain optional accessories to assist or enable movement. These may include:

- Rollers which can be oriented in two directions at 90°.
- Lifting lugs on the cover
- Channel underbase, which can be skidded or lifted using a forklift truck under the channels.

**Note. A transformer must never be lifted or moved using the corrugated radiator fin walls as an attachment point.**

## 1.4 Storage

Long term storage is obviously best in a dry and well-ventilated room. Hermetically sealed transformers may be stored outdoors indefinitely however any weathering or impact damage to paintwork should be attended to immediately to prevent corrosion.

## 2. Installation and connection to the power system

When connecting the transformer to the electrical power system full attention must be given to the following:

### 2.1 Connections

All electrical connections must have a sufficiently large, solid and clean contact surface. The use of the correct cable lugs, connection terminals or busbars normally achieves this. The incoming conductors must also be suitably rated. Care should be taken to avoid undue stresses on connection busbars or insulators by employing the correct cable supports and/or cable glanding arrangements.

## 2.2 LV Neutral

The neutral is normally brought out to an insulated terminal within the LV cable box. This may be earthed at a suitable earth point external to the transformer

## 2.3 Earthing

The transformer must be connected to a good earth. An earth terminal is available at the base of the tank. The minimum electrical resistance to earth is usually prescribed by the local power Supply Company. Keep the connection surface clean.

## 2.4 Accessories

Check the setting and operation of the different accessories installed.

- a) Check that the tap switch is in the middle position, normally tap position 3. Note the tap switch must never be adjusted with the transformer energised.
- b) The dials of measuring instruments, if fitted, should be clearly visible.
- c) Check that the drain valve seal does not leak and that the top filling point is secure and dry.
- d) Check that the HV and LV bushing insulators are clean and dry, if not then they must be wiped down with a dry cloth.
- e) Check the insulation resistance between HV/LV, LV to earth and HV to earth with an insulation meter.
- f) Check the continuity of the HV and LV coils.

## 2.5 Oil level

The oil liquid level should be verified. Do not attempt to fill a hermetically sealed transformer without first consulting Pauwels Trafo Service department.

## 2.6 Connections

The electrical connections of the transformer and of the protective devices must be fully verified as correct.

No foreign objects must be left inside cable boxes after cables are terminated.

## **3. Switching-on and operation**

### **3.1 HV energisation**

When the installation has been fully checked, the HV side can first be switched-on and following this, the LV side.

We recommend that the transformer is left energised for a few hours before switching-on the LV side and applying load. During this time the transformer should be closely supervised paying attention to both coolant oil level and temperature.

Verify the voltage between the low voltage phases and phase to neutral if used. The voltmeter should show no substantial differences between each phase to phase and each phase to neutral value. Remember that phase to phase is  $\sqrt{3}$  X phase to neutral on a star connected secondary. If any significant differences are found then the cause should be investigated before proceeding any further.

Verify that the measured no-load phase to neutral voltage is correct for the intended application. If the voltage is too high or too low then some initial variation can be achieved using the HV tap switch in the proper manner. Note the tap switch must never be operated or used with the transformer energised.

### **3.2 Re-adjusting the tap switch.**

The tap switch enables sections of the HV winding to be in or out of the turns ratio thus affecting the secondary low voltage side.

When the voltage measured at the low voltage side deviates from the required value this usually indicates that the incoming HV voltage is too high or too low. Normally the supply voltage is held within limits of plus or minus 6%. The tapping switch can compensate for variations of plus or minus 5% in 2.5% steps. If adjustment is desired then the following procedure should be followed.

- a) Disconnect the transformer from both the HV systems and the LV systems.
- b) Unlock and remove the padlock, if fitted. Release the tapping switch mechanism by lifting the operating handle.

c) Turn the handle to the desired position.

To increase LV volts - turn to a higher tap position number, which will decrease the HV, turns in circuit and proportionally increase the output voltage.

To decrease LV volts - turn to a lower tap position number, which will increase the HV, turns in circuit and proportionally decrease the output voltage.

The handle must fall securely into the desired position before locking off as necessary. The handle must **not** be allowed to stay in the in-between taps position.

Note. We accept no responsibility for damage to transformers or electrical installations due to faulty connections or incorrect operation.

### 3.3 Parallel operation - special points

Transformers connected in parallel have to comply with the appropriate regulations and conditions. (I.e. IEC 76 - 4 and IEC 606 chapter 4)

These are:

- That they should have the same phase relationship.
- The internal connections of the transformer may differ. There are 4 standardised coupling groups:

Group 1 contains Dd0, YNYn0, Dz0

Group 2 contains Dd6, YNyn6, Dz6

Group 3 contains Dyn5, YNd5, YNzn5

Group 4 contains Dyn11, YNd11, YNzn11

- The transformers must have the same impedance voltage with 10% tolerance.
- The transformers must have the same nominal voltage ratio.
- At a continuous parallel connection it is also important that the power rating of the transformers do not differ by more than a factor of 3. The transformer details can be found on the name and rating plate.

Before starting a parallel connection the following procedures should be applied:

- a) Check that HV and LV connections are correct and to the correct phase rotation and terminal markings.

- b) Ensure that the transformer tank is properly earthed.
- c) Energise the transformer with the low voltage system disconnected.
- d) Verify the voltage between the low voltage phases and phase to neutral. The voltmeter should show no substantial differences between each phase to phase and each phase to neutral value. Remember that phase to phase is  $\sqrt{3}$  X phase to neutral on a star connected secondary. If any significant differences are found then the cause should be investigated before proceeding any further.
- e) If there is no voltage difference between the respective low voltage terminals of the same name on parallel circuits then the main LV busbars can be energised on the low voltage side.

Note. We accept no responsibility for damage to transformers or electrical installations due to faulty connections or incorrect operation.

## 4 Maintenance

The hermetically sealed type transformer requires very little maintenance. The oil inside is entirely filled up to the lid in a manner known as integral filling. As such there is no gas cushion or venting to the atmosphere. This maintains the oil in excellent condition throughout the transformer's life due to the exclusion of contaminants from the outside environment.

### 4.1 Monthly

External inspection can be made once per month or in line with routine plant inspection schedules. This inspection may be made with the transformer energised as long as no live parts are accessible.

Checks should be made for signs of oil leakage or damage to paint.

The noise of the transformer should be listened to. Normally this is a dull 50Hz mains hum. If radically different sounds are noticed such as popping or fizzing then this should be reported and investigated immediately as it may require an urgent shutdown.

On the transformer supplied there may be optional devices fitted. I.e. temperature in the oil or over-pressure. In addition alarm and trip contacts may be provided for these optional devices.

	Normal	Alarm	Trip
Oil temperature	<85°C	85°C	95°C
Winding temperature	<95°C	95°C	105°C
Oil level	Yellow	Red	N/A
Over-pressure indication	No coloured flag	N/A	Coloured flag

The values given are recommended only and may be changed to suit design requirements or site conditions.

The measurements should be checked regularly to ensure that they are within normal limits.

## 4.2 Yearly

The operation of the protective devices should be verified once per year.

## 4.3 Five yearly

With the transformer de-energised, the tap change switch should be put into the different positions and the continuity of the internal connections verified by measuring the HV phase to phase winding resistance's. After the check the switch should be returned to its desired setting before re-energising.

An oil sample may be drawn and sent for testing to confirm the condition of the transformer oil.

## 4.4 Ten yearly

A full check by Pauwels Trafo Service is recommended.

## 4.5 Fault Indications

### Over-pressure

A fault is indicated if a pressure relay trip occurs. This would imply an internal fault or large overload in very warm conditions.

### Over temperature - oil or windings.

This would imply serious overloading or an internal fault.

### Low oil level

This would imply a leak or internal gassing and should be investigated immediately.

## 5 Transformer tank

### 5.1 Construction

The transformer tank is made up of three major components:

- a base
- a lid, welded or bolted to a frame
- corrugated fin walls welded between base and top-frame to create a completely oil-tight tank.

The materials are:

Corrugated walls for radiator surface - Cold rolled steel plate ST 12.03 to DIN 1623.

Cover - bottom - straight walls hot rolled steel plate A360 C according to NBN A21-101.

### 5.2 Active part mounting method

The core and windings assembly is effectively suspended from the tank cover and is removed by lifting the tank cover away from the tank. As the transformer is vacuum filled this should never be attempted unless proper facilities are available for reprocessing the active part and oil.

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