OPERATING MANUAL

OF

QTC ENERGY PUBLIC COMPANY LIMITED

Customer Service Contact Number : 089-444-0844

CONTENT

1. INTRODUCTION

1.1 General

This Operating & Maintenance Instruction Manual covers QTC Oil-Immersed Distribution Transformers, including Hermetically Sealed Type and Conservator Type Transformers, suitable for outdoor installation and indoor installation. It is intended to give a guideline for QTC Transformers with high voltage systems up to 33kV.
This manual is carefully prepared for use by experienced electrical engineers or experienced qualified electro-technical personnel, so it can be referred to in installation or maintenance of the transformers. However local engineering practices or regulations of any local government or authorities shall also be followed.

1.2 Precaution

Working on any transformers and/or electrical live parts can be dangerous to lives due to electric shock. Safety Precaution and regulations shall be strictly followed. Please read this manual carefully and check the transformer rating and details shown in the rating plate before attempting to install, handle or provide maintenance work for the transformers. If the rating plate is missing, please contact QTC Energy Public Company Limited. Failure to follow the manual or safety measure and regulations could result in personnel injury, life or property damage.

1.3 More Information

In case that more information is required, please contact us at below address.

QTC ENERGY PUBLIC COMPANY LIMITED
2/2 Soi Krungthep Kritha 8 (5), Huamark,
Bangkapi,
Bangkok 10240, Thailand
Tel. : (662) 379-3089 - 92
Fax. : (662) 379-3097

2. GENERAL PARTS OF QTC TRANSFORMER

2.1 HV. & LV. Bushings

HV and LV Bushings are the components installed on the top cover of the transformer (in some case, they are also installed on side wall of the transformer). They are made of porcelain with chocolate brown glazed color (in some cases, the HV bushings can be a plug-in bushing made of resin). The porcelain body consists of sheds which gives an insulation clearance by creepage distance.

HV and LV Bushings serve as insulation for the conductors from inside the transformer (HV conductor and LV conductor) to the external terminal connections for connecting cables. The sizes of the terminal connectors depend upon the current rating of the transformer.

HV. Bushing & Terminal

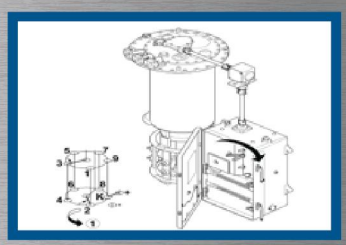
LV. Bushing & Terminal

2.2 Tap Changer

Tap changer provides a means of changing the voltage ratio of a de-energized transformer without breaking the transformer seal. It is operated by means of a rotatable handle located on the cover of the transformer. The handle is attached to the tap changer by means of a shaft which extends through the liquid tight packing gland in the tank. The number of tap changer positions is shown on the transformer nameplate. One tap position change requires one complete revolution of the external operating handle. The transformer must not be energized unless handle of the tap changer is locked in an operation position.

A locking position holds the tap changer handle in any of the tap position; the handle is allowed to move freely to the position desired. Once the tap changer locking is in position, the tap changer handle cannot be moved.

Off - Load Tap Changer



ON - Load Tap Changer

2. GENERAL PARTS OF QTC TRANSFORMER

Warning: Tap Changer can be operated when the transformer is DE-ENERGIZED only.

2.3 Dual Voltage Switch

If installed, the dual voltage switch provides a mean of changing the voltage system ratio of a de-energized transformer without breaking the QTC Energy Public Company Limited transformer seal. It is operated by means of a rotatable handle located on the cover of the transformer. The voltage system is shown on the transformer nameplate.

Dual voltage switch

2.4 Thermometer

The thermometer serves as the indicator of the temperature of the transformer oil. It can be glass type or bimetal dial type.

Thermometer

2. GENERAL PARTS OF QTC TRANSFORMER

2.5 Name Plate

A rating plate is fixed on the side of transformer. It gives important information about the transformer according to relevant standards (i.e. IEC, AS or ANSI), which includes:

2.5.1 Serial number : Specific number given to each transformer made by QTC. Please refer to this number to identify the specific transformer when contacting QTC.

2.5.2 kVA : The rated power of transformer in kilovolt-ampere (kVA) that transformer can transmit power without exceeding the temperature rise

2.5.3 Phase : Number of phase at which the transformer is designed to operate.

2.5.4 Frequency : Rated frequency at which the transformer is designed to operate, in Hz

2.5.5 Voltage & Ampere : Rated voltage and current of primary and secondary of the transformer, in V and A.

2.5.6 Type : Type of cooling of the transformer.

2.5.7 Class : Class of insulation of the transformer.

2.5.8 Oil temperature rise (^{o}C) : Maximum top oil temperature rise over ambient temperature at rated kVA.

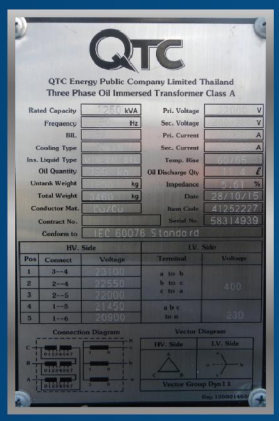
2.5.9 Impedance : The % impedance voltage of the transformer, measured by testing.

2.5.10 Oil quantity : Volume of oil in the transformer in liters.

2.5.11 Untank weight : Weight of the internal part of the transformer inside the tank. This weight indicates the weight when lifting the part out of the transformer tank, in kg.

2.5.12 Total weight : Transformer total weight in kg.

2.5.13 Connection diagram : Connection diagram of the transformer windings.



Rating Plate

2. GENERAL PARTS OF QTC TRANSFORMER

2.6 Drain Valve

A drain valve is located at the bottom of the transformer tank. It will be used to drain the oil and for testing of oil characteristics. Normally the transformer can be used for over 5 years without any oil filtration or replacement. If oil replacement is necessary, it should be carried out by QTC Services Personnel, or by qualified personnel only. For Hermetically Sealed Transformers, the filling of oil is to be performed by the control of transformer tank pressure.

Drain Valve

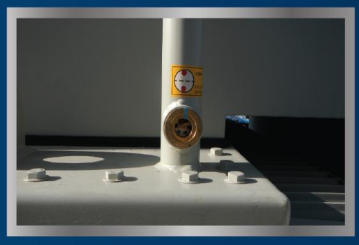
2.7 Earthing Terminal

Earthing terminals are located at the bottom of the transformer tank or at the transformer base. Earthing terminals of installed transformers shall be connected to a grounding wire or ground rod, and grounding resistance shall be according to the standards.

Earthing Terminal

2.8 Oil Level Gauge (Option)

An oil level gauge is an optional for hermetically sealed transformer. It will be installed on the oil filling pipe. The level indication is by a float ball. For Conservator type transformer, the oil level gauge will be installed on the Conservator tank. It can be either a sight glass or dial type oil level gauge.



Oil Level Gauge

2. GENERAL PARTS OF QTC TRANSFORMER

2.9 Conservator Tank

Conservator tanks are installed on conservator type transformer only. It is a cylindrical shaped tank, located above the transformer tank. It is connected to the transformer main tank via a pipe. The conservator tank serves as an expansion tank for transformer oil can expand due to heat during transformer loading. For Hermetically sealed transformers, there is no conservator tank, as the oil volumetric expansion will be through the flexible corrugated wall tank. This is why it is important to keep this type of transformer under vacuum.

2.10 Dehydrating Breather

Dehydrating breather is fitted to the conservator tank. It is the inlet and outlet of the air flow into and out of the conservator tank. The dehydrating breather is filled with silica gel, which will absorb any moisture in air to prevent it from entering the transformer and contaminating the oil inside the conservator tank.

3. HANDLING

3.1 Lifting

Lifting eyes are provided on the tank and lifting lugs are provided under upper frame of the transformer. Lifting eyes on the tank shall be used for lifting the complete transformer, and lifting lugs on the upper frame will be used for lifting the empty tank. Please see data regarding weight on the nameplate before lifting.

3.2 Jacking

For lifting by jacking method, please use jacking pad located at the lower part of transformer tank only.

3.3 Tilting

The transformer must not be tilted more than fifteen degrees (15 degree) (this is the degree between the horizontal line and vertical angle of the transformer) during handling. Tilting beyond that can cause damage to the internal structure of the transformer.

4. STORAGE BEFORE INSTALLATION

4.1 Transformer shall be stored on a paved floor indoor or outdoor.

4.2 Avoid laying the transformer on a soft floor this may cause the transformer to tilt.

4.3 Avoid laying the transformer in an area where there is a risk of anything fallen on the transformer.

4.4 Avoid storing the transformer in wet or flooded area.

4.5 The transformer shall not be stored in a dusty area, but if necessary, the transformer is to be covered by plastic sheet or similar material.

4.6 The transformer shall not be stored near a heat source.

5. INSTALLATION

5.1 External Inspection

Before start to installation , please check transformer according to procedure in chapter 6

5.2 Preparing installation area

5.2.1 Transformers shall be installed in an area with good ventilation and with convenient access for maintenance personnel.

5.2.2 Transformer shall be installed in an area with a wall or fence around it, except if being installed on a pole. The wall or fence must have a lock and the area must be accordance with the standards or local regulations.

5.2.3 The clearance distance to the wall or fence from the transformer and the electrical live part of high voltage system must not be less than 107 cm. for voltage not exceeding 12kV, and 115 cm. for voltage not exceeding 24kV, or according to the local regulation.

5.2.4 The clearance distance to the wall or fence from the transformer must not be less than 100 cm. And the clearance between each transformer must not be less than 60 cm.

5.3 Connection on HV and LV Side.

5.3.1 HV Connection

Use the size of conductor in accordance with the local standard or regulation. Conductor or cable weight shall be taken into account when connecting to the HV Bushings. As to much stress on the bushings can cause the bushing gasket to leak.

5. INSTALLATION

5.3.2 LV Connection

Use the size of cable or bus duct in accordance with standard or regulation.Weight of cable shall be taken into account when connecting to the LV Bushings. Bus duct connection alignment between bus duct and transformer cable box is to be accurate. To avoid pressure on the bushing gasket, this in turn will avoid breaking the gasket seal.

6. Routine Maintenance & Check of the Transformers

The causes of the transformer failure can be classified as follows:

6.1 Mechanical Faults

6.1.1 Crack or chip on porcelain bushing, or broken bushing due to transportation or mishandling.

6.1.2 Leak on transformer tank or conservator tank.

6.1.3 Oil leak from gasket or loosened bolt & nut or deteriorating rubber o-ring.

6.2 Electrical Faults

6.2.1 Deteriorating insulating oil, high moisture content. This can be checked with Oil Dielectric Test. The deteriorating insulating oil can lead to the short circuit between coils or electric arc at the tap changer connection.

6.2.2 Aging insulation paper or insufficient for the working voltage. This can lead to the short circuit of the coils. There will be indication of the burnt insulation on the coils, and, in turn, affect the quality of the insulating oil.

6.2.3 Prolonged overloading of the transformer. Overloading for long period can cause the overheating in the coils and insulation. This overheating leads to the insulation failure and severe short circuit in the coils. Insulating oil also burn and being contaminated with combustion products.

6.2.4 Overvoltage above the transformer withstands level. Overvoltage include lightning strike, switching impulse overvoltage, which can cause spot burn on the top layers of the coils. Mostly the insulating oil does not burn.

6.2.5 External short circuit. External short-circuit of the load or cable cause the severe over-current through the windings, which, in turn, result in extreme mechanical force on the windings.

6.2.6 The failure in magnetic circuit. This failure is due to the deteriorating silicon steel, due to service over long period, moisture contamination in the insulating oil, or insulation between magnetic sheets. This results in the rust on magnetic sheets and short circuit between sheets. Routine maintenance and check of the transformers can help prevent the above failure.

6. Routine Maintenance & Check of the Transformers

The Routine maintenance can easily and safely be carried out according to the Annual Routine Maintenance & Check Sheet as following.

Table 1: Guideline for Routine Check and Maintenance

No.	Part	Inspection/ Check	Rectification or Maintenance Details
1	Terminal Connector 1.1 HV 1.2 LV	- Check for any rust and loosened bolt/nut. - Check if terminals are in good condition. - Tighten the bolt and nut of terminal using a torque wrench.	- Tighten the bolt and nut of terminal using wrench. - Tighten the loosened bolt or nut. - Replace with new terminal or bolt/nut if necessary
2	Bushings 2.1 HV 2.2 LV	- Appearance check if there is any chip or crack on the bushing porcelain. - Check for cleanliness of the bushing surface.	- Bushing porcelain surface shall be shiny clean. - De-energize the transformer before cleaning the bushing porcelain. - Replace with new bushing, if damaged.
3	Gasket	- Check if there is any oil leak from tank cover, valve or flanges. - Check whether gasket is in good condition.	- Worn gasket or oil leak from tank cover or flanges joints, the gasket has to be replaced.
4	Tap Changer	- Check the position of the tap handle - Check if any oil leak from tap handle.	- Record the position of tap changer. - If transformer voltage is above or below the rated for long time, change the tap changer to required position. Warning: de-energize transformer before tap changing.

6. Routine Maintenance & Check of the Transformers

No.	Part	Inspection/ Check	Rectification or Maintenance Details
5	Oil	- Check the oil level. - Check if any oil leaking at the oil level gauge. - Check if any water is in the sight glass of the oil level gauge. - Test oil dielectric breakdown voltage, at least 1time/year.	- In the case that the oil level is at the same level all time (whether the transformer load is increased or decreased), or the oil level is abnormally low, it may be due to: • Oil level gauge malfunction • Oil leakage - If any mist or water inside the oil level gauge, check seal of the gauge.
6	Thermometer	- Check, record and compare the oil temperature with the past record.	- If the temperature looks abnormal, it may be due to: • Thermometer malfunction • Transformer overload • Dirty cooling fins
7	Drain Valve	- Check for any oil leaks, and check whether the valve can be turned to the open and close position	- Repair any leak point, and replace if valve cannot be operated.
8	Earthing Terminal	- Check whether the earth terminal is connected to the ground rod or the grounding system. - Check whether the earth connection is electrically connected and tightened.	- If the transformer tank earth terminal is not connected to any ground rod, install the ground rod and grounding cable connection. - Clean the contact surface and tighten the earthing terminal connection.
9	Leakage	- Check whether any valve or flange joints or cooling fins are leaked.	- Tighten bolt/nut on flange joint. - Replace new gasket if necessary. - Leaked welding seams can be repaired with sealing a gent or by welding.
10	Silica gel in dehydrating breather (for conservator type only)	- Check whether the color of silica gel is changed.	- Normal color of silica gel is orange or blue, if the color turns to be black/grey or pink, it has fully absorbed the moisture, so it needs be replaced.

6. Routine Maintenance & Check of the Transformers

INSULATION RESISTANCE TESTER

1. Measurement of Insulation Resistance between Primary and Secondary Windings (P – S)
2. Measurement of Insulation Resistance between Primary and Tank (P – E)
3. Measurement of Insulation Resistance between Secondary and Tank (S – E)

Table 2 : the minimum insulation resistance (Mega Ohm) for transformer with each system voltage:

System voltage	20 ˚C	25 ˚C	30 ˚C	35 ˚C	40 ˚C	50 ˚C	60 ˚C
22 kV. – 33 kV.	1000	750	500	375	250	125	65
11 kV.	800	600	400	300	200	100	50
3.5 kV. and below	400	300	200	150	100	50	25

Normally for transformer with system voltage of 22kV, the insulation resistance at 30C shall not be less than 500 Mega ohm. If the insulation resistance is above 500 Mega ohms, then it is allowed to be switched on. Generally the new transformer from the factory shall have insulation resistance of at least 2,000 Mega ohms.
In case, the insulation resistance is below the values in the above table, transformer shall be re-dried out in the vacuum oven, or the transformer oil shall be filtered or replaced.

7. Appendix

7.1 Oil Thermometer with contacts (alarm/trip)

When this device alarms it means the transformer is in overload. Check the temperature indicator pointer and contact QTC service team immediately, QTC standard alarm 90 deg.C /trip 100 deg.C

7.2 Pressure relief device with contact (trip)

When this device trips it means the tank pressure has risen due to a fault in the transformer. Shutdown the transformer, re-check the temperature indicator and contact QTC service team immediately, Factory default setting alarm/trip 0.35bar

7. Appendix

7.3 Buchholz relay (alarm/trip)

When this device trips it means the transformer needs checking. Check the transformer can be three reasons

1. for oil leaking (Visual check)
2. gas inside the transformer
3. faulty of Buchholz

Contact QTC service team immediately, to trip the alarm gas volume needs to be 125 cm^3

Measurement of Oil Dielectric Strength (break down voltage):

- Take an oil sample from the bottom of transformer tank, via oil drain valve.
- Take an oil sample from the bottom of conservator tank.

The oil dielectric break-down voltage, obtained from testing with 2.5mm gap, shall not be below the values given in Table 3.

Table 3: Minimum oil dielectric break-down voltage for transformer with each system voltage.

System voltage (kV)	Break-down voltage / 2.5 mm.
3.5	20
11	25
22	30
33	32

1. In a case, where there is water or sludge contamination in oil, the oil break-down voltage is below the value in the table 3, and insulation resistance is also below the value in the table 2:
   a. The transformer shall be dried under vacuum.
   b. Transformer oil shall be filtered or replaced with new oil.

2. In a case, where there is water or sludge contamination in oil and the oil break-down voltage is below the value in Table 3, but the insulation resistance is above the value in Table 2:
   a. Transformer oil shall be filtered or replaced with new oil.