BEZ TRANSFORMÁTORY
MANUFACTURING TRANSFORMERS SINCE 1902

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

Technical regulation of the oil-immersed transformer with the corrugated tank

TPR 706 ANG

TABLE OF CONTENTS

Number of pages: 12
Edition: 2
Pripared by: Technical Department
Bratislava: May 2024

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

INTRODUCTION

The dispatched transformer is top filled with oil, (hermetically) sealed and furnished with equipment, which is either built-in or delivered separately. Immediately, a transformer is received, it should be thoroughly examined externally for possible damage which may have occurred during transit as well as for completeness of all components within the scope of supply. Any damage found (reason and extent of damage) as well as the missing components shall be reported to the carrier and to the manufacturer.

1. DOCUMENTATION

Technical regulation (TPR) refers to the standard designed three-phase oil immersed transformer according to the catalogue BEZ TRANSFORMÁTORY, a. s.

Technical regulation is to be kept for the future reference and it must be available at any time for qualified personnel.

Have you any questions regarding the submitted Technical regulation or regarding other properties of transformer, please contact the manufacturer trade agency or directly the manufacturer.

The basic data about the transformer can be found on the rating plate attached to the transformer. Check whether the data on the rating plate are equivalent with requirements specified in an order. Is it not the case, please contact the manufacturer trade agency or directly the manufacturer. You have to specify the serial number, year of production, type and power of transformer.

The results of routine test, special tests agreed and the wiring diagram can you find in attached documentation.

The specified application - The transformer is manufactured in accordance with the customer requirements. It can be put into operation only under conditions specified in the order. Have these conditions been changed or some alternations have to be done, please contact the manufacturer immediately.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

2. SAFETTY PRECAUTIONS

The transformer can be operated by electrically skilled personnel or the personnel being informed under attendance of electrical engineer only. The service personnel are obliged to study this Technical regulation, especially the chapter "Safety precautions" in advance.

At any work on the transformer the following procedures must be followed:

1. **To switch off the no-load transformer.**
2. **To secure the transformer against the re-switch on.**
3. **To define the out-off-voltage state of transformer.**
4. **To earth and short circuit the transformer**
5. **To disconnect or shut down the adjacent live parts**

To avoid any personal hazard the transformer must be installed in such a way, that no access to it will be possible during its operation. The safety precautions must be taken in order to ensure that the transformer will be accessible only when disconnected from net on both sides.

Provided that one winding is energized, the other windings are energized too.

All regional instructions (building regulations, directives for installation of electrical equipment, regulations for transformers, environmental protection, etc.) as well as standard EN IEC 61936-1 (Power installations for alternating voltages exceeding 1 kV and direct voltages exceeding 1.5 kV. Part 1: Alternating voltage) must be strictly observed.

The manufacturer does not bear the responsibility and guaranty for the cases, in which the direct or indirect damages of the transformer have been occurred owing to not being installed and operated according to the operating instructions. The same refers to non-respect of general safety precautions even not mentioned in this technical regulation.

2.1 Evaluation of residual dangers at specified working and user's conditions of transformer

The user is liable for making preparations in order to take under control the consequences of an electrical shock or accident. He must ensure and check the condition of equipment on transformer site.

The following hazards threatening the human health, property and environment go along with transformer operation:

2.1.1 Electrical hazards:

Direct contact with hazardous live parts.

- Indirect contact (with exposed-conductive parts which have become live under fault condition).
- Overvoltage after-effects at atmospheric and switching surge phenomenon.
- Access to the live parts being under high voltage.

Protection against the direct contact with live parts shall be ensured in compliance with the national regulations. It is necessary to enable the access and to allow the manipulation for qualified personnel only.

2.1.2 Thermal hazards

- Burn risk by contact with transformer components (bushing, tank, etc.) without safety facilities.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

The access to the transformer is allowed for qualified personnel only.

2.1.3 Mechanical hazards:

- Improper manipulation when lifting and pulling the transformer.

2.1.4 Fire or explosion hazard:

- Destruction of transformer tank when some failure occurs.
- Explosion owing to incorrect procedure when repairing the transformer.

Special attention is to be paid to the tank disassembly. Prior to loosening the screws a protective zone of at least 3 m around the transformer shall be created, in which smokings, working with open flame or with any other sources of high temperature is forbidden. After draining oil through the drain valve it is recommended to extrude the combustible gases as a result of an electrical breakdown. The extruding of inflammable gases shall be performed in the following way: the inert gas or nitrogen in quantity of 1.5-multiple of oil volume shall be blown inside through the oil filling tube on the top of the transformer cover thus extruding the inflammable gasses through a drain valve. After finishing this process it is recommended to let the gas leaking also through the oil filling tube for a while (minimum 5 minutes). After accomplishing the above described measures the disassembly of the tank can start. Loose the tank screws by means of the pneumatic tools (under any circumstances do not use the open flame). When the inner parts of transformer are withdrawn out of the tank, the protective zone can be cancelled.

The national regulations for outdoor and indoor installation of transformers must be observed. The site of transformer must create an independent fire cell. Instructions described in these Technical regulations have to be observed when repairing the transformer.

2.1.5 Chemical hazard:

- Exposure by agents threatening the human life.
- Acording to the oil temperature the hermetically sealed transformer is either under internal negative pressure or overpressure. This state must be taken into account during the emergency opening of the transformer.

The practice recommended after oil exposition is described in the Safety Data Sheet.

2.1.6 Noise and vibrations hazard:

- Noise and vibration emission.

The increased noise and vibrations indicate the malfunction of transformer. It is necessary to consult the manufacturer.

When installing the transformer the specified characteristics of the transformer must be taken into consideration by designer.

3. TRANSFORMER DESCRIPTION

The transformers are intended for outdoor operation (for indoor operation only when ventilated properly), with natural cooling ONAN, at continuous loading.

Main working conditions:

- altitude up to 1 000 m;
- temperature of cooling air ranged from - 25°C up to 40°C (the everage month temeperature of the hottest month 30ºC and the average year temperature 20ºC may not be exceeded), **unless otherwise specified**.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

Technical standards

The transformers are manufactured according to set of standards EN 60076.

Temperature rise

The design of transformers refers to insulating class 105°C (A) according to EN 60085. The average temperature rise of winding of 65 K and the temperature rise of top oil of 60 K must not be exceeded. **Different temperature rise values can be valid for different working conditions.**

Loading

Transformers can be loaded with output exceeding the rated power according to rules specified in IEC 60076-7.

Instructions

As far as the protection of persons, property and environment is concerned, in each country the different rules are valid for oil immersed transformers.

3.1 Transformer design

By varying of temperature of dielectric liquid (generally mineral oil) used for cooling of winding during the transformer operation, the volume of dielectric liquid is changing. This volume changing is compensated by proper construction of transformer consisting of two different designs:

- Hermetically sealed transformer (the transformer tank containing the active parts is hermetically sealed; its elastic corrugated walls compensate the changing of volume of dielectric liquid).
- *None hermetically sealed transformer with conservator.*

Magnetic Core

Magnetic core is made of grain oriented transformer steel sheets in step-lap method. The yokes are pressed either with steel or wooden frame construction.

Windings

Both HV and LV windings are made either of thin copper or aluminium bands or of wires insulated with paper or enamel. The whole winding arrangement guarantees the high electrical strength and mechanical stability as well as an efficient cooling of the transformer.

Outlets

The both high- and low voltage outlets are ended with bushings mounted on the top of tank cover according to EN 50180 and EN 50386 by default, unless otherwise specified. LV bushings can be furnished with connecting flag shapes according to DIN 43 675 - Flat connectors. Porcelain LV bushings can be furnished with a protection cover.

Tapings

Voltage regulation in range of ± 2 x 2,5 % (or ± 4 %, or ± 5 %) of nominal high voltage is carried out **on a disconnected transformer** by means of an off-circuit tap changer with its mechanically operated handle on the top of tank cover (see Appendix P2).

Tank (hermetically sealed)

The transformer tank is made of elastic corrugated walls compensating the volume changes of dielectric liquid during the transformer operation. The tank is furnished with an undercarriage whose bi-directional rollers can be converted from along to transverse moving. At the bottom of the tank an oil drain valve according to EN 50216-4 is located. The undercarriage is furnished with a M12 earth terminal. Transformer tank is hermetically sealed by means of a cover screwed to the tank frame.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

Tank (*with conservator)*

The transformer tank is made of elastic corrugated walls. The tank is furnished with an undercarriage whose bi-directional rollers can be converted from along to transverse moving. At the bottom of the tank a drain valve according to EN 50216-4 is located.

The transformer is closed by a cover screwed to the tank frame. On the top of the tank a conservator is located.

On the top of the conservator an oil-level gauge, oil filler and at rating 315 kVA and higher also a dehydrating breather (on customer demand even with a lower power) are located. At the rating 315 kVA and higher a gas relay and at the rating 1 000 kVA and higher also a closing valve can be installed instead of a distance piece inside of pipe between the conservator and the transformer tank. The use of the gas relay at smaller ratings must be consulted with the manufacturer.

Accessories

The thermometer pocket on the top of the tank cover is intended for installing a contact thermometer. The thermometer pocket must be top-filled with oil when installing the thermometer. The thermometer is supplied on the customer demand.

On the top of the cover (hermetically sealed design) oil filling tube is located. This filling tube is intended for filling the transformer with oil during the pressure adjustment in the hermetically sealed tank (see Appendix P1).

On customer demand it is possible to mount a pressure–relief valve on the top of the oil filling tube.

An earth nut M12 is located on the top of the transformer cover.

On customer demand, it is possible to furnish the transformer with another additional accessory (resistamce thermometer, oil level gauge, Integrated Safety Detector for monitoring of temperature, pressure, oil level and gases development, etc.).

Warning!

In order not to damage the sealing of the transformer, it is not allowed to handle the oil outlet valve or oil filling plug on the top of the tank cover (of hermetically sealed transformer). All these parts are factory sealed.

4. DISPATCH AND STORAGE

During the transportation the transformer is fastened to the deck of vehicle by wooden bulks. Before unloading of the transformer these bulks shall be removed. By means of four holes in the tank frame the transformer shall be fastend to vehicle at four sides during the transportation.

Four holes in the tank frame are used for the fasting the transformer during the transportation.

The relevant rules are to be observed when using the lifting equipment, high-lift trucks etc.

The value of transformer weight can be found either in a delivery note or on a rating plate.

The maximum shipping weight of transport equipment is to be kept.

It is forbidden to handle or lift the transformer by the cooling fins of the tank.

The rollers adjustment

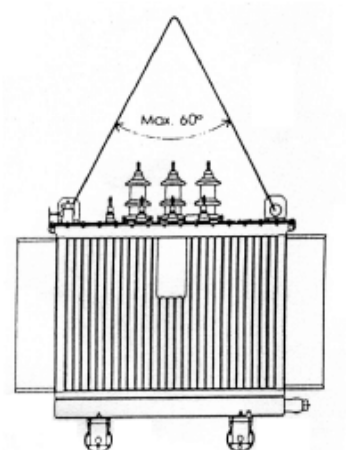
During the transportation the rollers are removed from undercarriage. Prior to mounting the rollers, the transformer shall be lifted by means of a lifting device (crane) and the wooden bulks shall be put under the transformer. The rollers shall be mounted and set to the direction required. The rollers are adjustable in two

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

directions. Lifting the installed transformer above the ground using wheels is necessary to ensure cooling of the transformer.

Lifting up

It is allowed to lift the transformer only by lifting lugs on the top of the tank and the points intended for lifting.



Dragging

For dragging of the transformer a hole either in the undercarriage or in the tank reinforcement is intended.

Transportation by means of a forklift

The lifting of the transformer by means of a forklift is allowed provided that the skids of the forklift will be inserted along the outside of the undercarriage beams.

Storage

The transformer must be stocked in a safe place (fenced and secured) and protected against the pollution. The transformer must be installed in the horizontal position.

5. TRANSFORMER INSTALLATION

The transformer shall be put on the foreseen site and ensured against the movement. The sufficient ventilation shall be ensured.

According to site conditions the shock vibration damper is installed under the rollers.

The transformer shall be earthed.

The procedure described belov shall be choised in accordance with the transformer design:

a) Attach the cable box to the flange located either on the cover or on the wall of the transformer tank and fix it to the flange by means of connecting accessories.

b) Connect the earth screws on the cable box with those on the cover or on the wall of the transformer tank with the yellow-green earth wire.

c) Remove the cover of the cable box and connect the cables to corresponding bushings. Cables go through an aluminum plate. Drill holes into this plate and install the cable glands to seal the cables. Cable glands are not included.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

All joints shall be cleaned and made without twisting. Cupal plates must be used when connecting Al-Cu pieces. On the top of all joints the anticorrosive protection shall be applied. Cables shall be furnished with a tension relieve. For currents ≥ 1,000 amps, use the flexible couplings between the transformer terminals and bus bars.

The anticorrosive protection (Vaseline and similar) shall be applied on the top of all screw joints.

6. COMMISIONING

This method refers to all newly installed transformers, the transformers putting into operation after revision or repair and the transformers being out of operation for a long time.

6.1 Check of the transformer

Prior to connection of the transformer to the network be sure the transformer has not been damaged during the transport or storage or whether its dielectric properties have not been worsened considerably during the long-run storage or whether it is not polluted. The transformer must be installed in the horizontal position.

The following must be checked:

a) Whether the seals are not broken (drain valve, oil filling plug, cover). The broken seals should be reported to the manufacturer.

b) The condition of gaskets (cover, bushings, valves) and oil-tightness of welds. In case of some leakage, the transformer shall not be put into operation, but the possible damages should be reported to the manufacturer, who provided for removing them and re-sealing of the transformer.

c) Insulating resistance of winding (e.g. by measuring instrument up to 2 500 V). The minimum resistance value should be 1 GΩ. If the insulating state is not sufficient due to damage of the transformer, it is necessary to consult the transformer manufacturer.

d) Whether the windings are not interrupted.

e) Right position of the tap changer.

f) Right connection of transformer terminals on corresponding phases of the distribution system.

g) Vector group and the phase displacement in case of a parallel operation.

h) Whether there is not any voltage difference between corresponding terminals on the output side of parallel operating transformers.

i) Earth of the transformer prior to its connection to network (earth resistance according to valid regional rules and directive of Electrical Power Distribution Company).

j) Function of safety devices.

Checks performed only on transformers with a conservator:

k) Oil level in conservator. When necessary, top up the conservator with clean transformer oil so that at 20°C the oil level reaches the mark + 20°C.

l) Condition of the filler and oil level in the dehydrating breather, if used.

m) If the dehydrating breather is not installed, the following steps are to be made:

- *Unscrew the cap nut of the pipe of dehydrating breather located on the top of the conservator.*
- *Remove the plastic cover from the dehydrating breather.*
- *Screw the dehydrating breather furnished with gasket on.*
- *Fill up the glass bowl with the oil up to the line.*

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

n) If mounted on the transformer gas relay or valve, its correct function and the opening of valve located between the tank and the conservator are checked.

In addition to revision of the transformer and its accessories it is necessary to check (in the transformer with conservator) also the dielectric strength of oil which must comply with the value of factory new oil.

6.2 Connecting the transformer to the network

If no damages have been found during the check, the transformer shall be connected to network according to the wiring diagram supplied within the scope of the documentation:

- Connection to the network must be performed in a no-load operation.
- HV side will be connected as the first one, following by the LV side.
- Than the transformer will be gradually loaded.

7. CHECKS AND REVISIONS OF THE TRANSFORMER

7.1 Checks of the transformer in operation

Please, keep the safety distance from the equipment.

The following shall be checked (it is recommended once a year):

a) Whether the seals are not broken.

b) Oil tightness.

c) Voltages and currents LV in all phases, if possible (whether the transformer is not overloaded).

d) Ambient temperature.

e) Transformer noise.

f) Function of safety device.

Checks performed only on transformers with a conservator:

g) Oil level in conservator.

h) Condition of filler and oil level in dehydrating breather (if used).

7.2 Routine revisions

One year after putting into operation it is recommended to disconnect the transformer in all lead-in wires, and to check:

a) Oil tightness of the transformer.

b) Position and setting of the tap changer.

c) Tightening of bushing screws.

d) Extent of the pollution of bushings, tank surface and cover.

e) Earth of the transformer.

f) Function of safety device.

If no failure has been occurred during the transformer operation, it is recommended to repeat this revision after 5 years.

Checks performed only on transformers with a conservator:

g) Oil level in conservator.

h) Condition of silica-gel (when necessary replace it) and oil level in dehydrating breather, if used.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

i) Insulating properties of oil.

j) Function of the gas relay, if used.

If no failure has been occurred during the transformer operation, it is recommended to repeat this revision after 2-3 years, unless otherwise specified by regional rules.

It is recommended to check the properties of insulation liquid after every 6 years (EN 60422). Minimum breakdown voltage of insulating liquid is ≥ 30 kV. This value is determined by testing of a sample according to EN 60156.

APPENDICES

P1 Filling and correcting of oil volume in the transformer tank

Hermetically sealed transformers

1. When the transformer was repaired (i.e. the active part was withdrawn out of the tank), when the oil must be replaced or when a large volume of oil leaked out, the transformer must be re-filled with oil in a vacuum chamber.
2. Prior to drop of oil level in transformer tank, e.g. when replacing a HV bushing, open the oil outlet and let oil to drain out as long as the pressure will be balanced. Open the cap on the oil filling tube and let oil to drain out of the transformer tank – maximum drop of oil level is 50 mm. Trough the oil filling tube the oil level by means of a gauge-stick.
3. When re-filling the transformer with oil top it up with oil through the oil filler tube. Observe and keep this level stabile.

   Loose the hexagonal nut holding the head and press the bolt down into the insulating body thus loosing the sealing ring and letting air to to vent out of the HV bushing.

   After removing the air bubbles screw the hexagonal nut on. Clean carefully any oil that may have leaked out of the device. Wentilate the other accessory on the tank cover in the similar way.
4. Top up the oil filling tube with oil and close it putting a gasket and screwing a plug on.
5. Measure the temperature of transformer oil in the thermometer pocket located on the top of the tank cover. According to this temperature calculate the volume of oil which must be drained out. Through a connecting piece open the oil outlet and let the oil volume calculated drain out avoiding the air to penetrate in to the transformer.
6. Formula for calculation of oil volume to be drained out:

   $\Delta V = k \times G_{oil} \times (t_{oil} - 30)$ (dm^3)

   k = 0,000845 – for mineral oil

   k = 0,000719 – for ester (MIDEL 7131)

   k = 0,001099 – for silicon oil

   G_{oil} - oil/ester weight in kg specified in the rating plate

   t_{oil} - oil/ester temperature inside of the transformer in °C.
7. Close the oil outlet through the connecting piece and dismount the connecting piece.

   When the transformer is top filled with oil according to this instruction (hermetically sealing), any other construction parts can not be vent more.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

P2 Voltage variation by tap changer

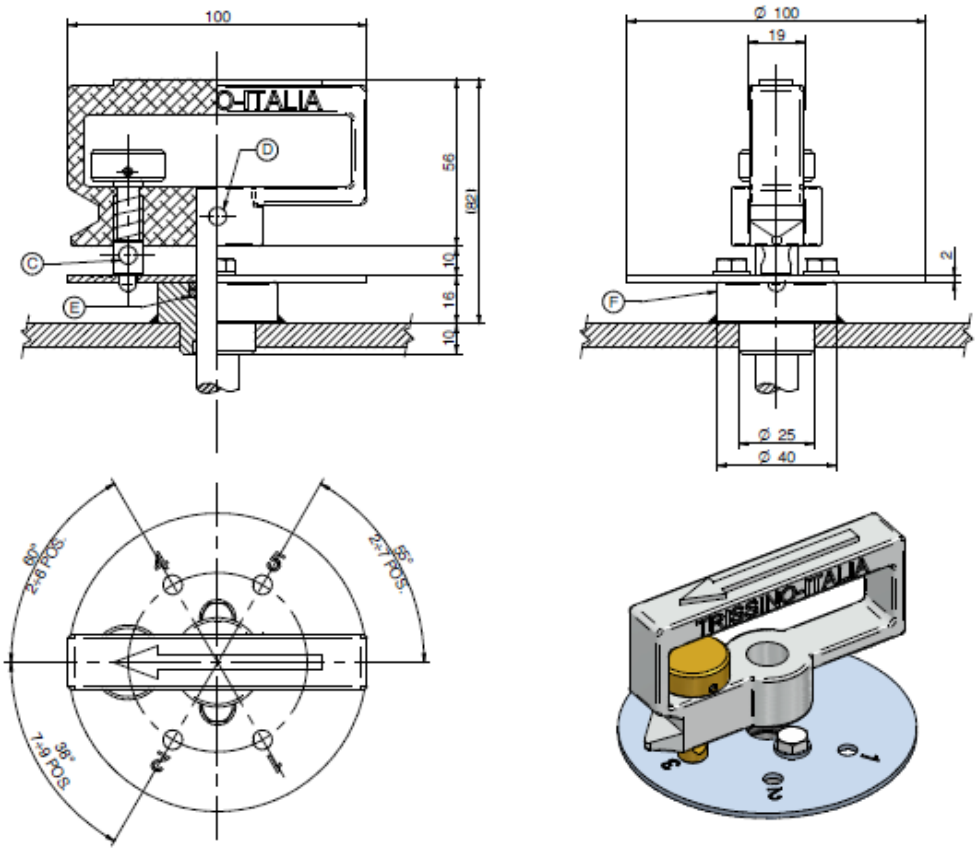
The adjustment of the tap-changer may be performed on **disconnected transformer only.**

Proceed as follows (figure):

The head of tap changer is arrested in the certain position by means of a cap screw. Loose the cap screw and turn the head of tap changer to the desired position indicator (number and arrow) concides with the indicator (arrow) on the base (red) board.

Screw the cap screw on thus re-arresting the head of the tap changer.

In case of the tap changer design with a head with a handle, the head is locked by a mechanical locking latch:



C) Hole ø6 for padlock.

D) Hole for pin ø6 to be drilled during the assembling.

E) N°2 gasket OR 3056

F) Steel stuffing box to be welded to the lid of transformer.

- Handle is composed by stuffing box, inox-steel index disc and aluminium handle with mechanical block on the position.

BEZ TRANSFORMÁTORY, a.s.
Rybničná 40, 835 54 Bratislava, Slovakia
Tel.: +421 918 791 820
e-mail: bez.or@bez.sk | bez-transformers.com

ATTENTION!!!

In case of changing tap changer position, proceed as follows:

1. Lift up the mechanical locking flap (on the up-mention figure marked in gold).
2. Turn the tap changer handle in desired direction.

ATTENTION!!!

In any case, do not pull (do not lift up) the tap changer handle overhead – there is a risk of tearing the handle from the tap changer and thereby damage of the entire tap changer.

P3 Tightening torque

It is important to check, whether the bushings are not exposed to a load caused by cable and bus-bar outlets. This load can cause the leakage of oil/ester at the joints of bushing parts.

Moreover the following tightening torques must be observed:

Table of tightening torques recommended

Tightening torque	Bushing bolts HV EN 50180	M12	10 Nm
	Bushing bolts LV EN 50386	M12	15 Nm
		M20	35 Nm
		M30 x 2	100 Nm
		M42 x 3	100 Nm
		M48 x 3	150 Nm

Permissible deviation from the tightening torque is ± 10 %.