10T4-094374A

TECHNICAL DOCUMENTATION
Manual

Three-phase Oil-immersed Transformers

MINERA type

power up to 4000 kVA and voltage up to 35kV.

Hermetic design.

Attention: Do not switch the transformer on before you are well familiarized with this documentation.

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CONTENT

1. General

This Technical Documentation refers to the transformers of MINERA type, hermetic design, manufactured by Schneider Electric Energy Poland Sp. z o. o. Mikołowska Fabryka Transformatorów. This documentation can also be applied to other transformers with hermetic design manufactured by Schneider Electric Energy Poland Sp. z o. o. with following names: TNOSP, TNOSPA, TNOSN, TNOSNG, TNOSNA, TNOSR and TNOSRA.

Rules and recommendations placed in this Technical Documentation should be strictly respected by transformer user.. Not respecting the rules and the recommendations can lead to the transformer damage, can create risk for people working with the transformer and can lead to loss of warranty.

2. Rating data and technical information

The MINERA type transformers are distribution transformers, where the best materials, proved to be highly effective, the most up-to-date production technology and design, have been applied to provide the end-user with a product ensuring the highest professional satisfaction.
The transformers are made as hermetic, to be operated practically as maintenance-free. They are characterized by:

- low level of losses,
- reinforced insulation system,
- new type of tap-changer with a gear-type drive, easy operated.

The range of transformer power is up to 4000 kVA at the nominal voltage of the primary winding up to 35 kV. The transformers are manufactured with 6 HV voltage series: 1 kV, 10 kV, 20 kV, 25 kV, 30 kV and 35 kV. The rated voltage at the LV side can be up to 6300 V according to a specific customer request (400 V and 420 V are standard).
The transformers are fully filled with non-inhibited oil, without a gas cushion under the transformer tank cover (unless other design was agreed in contract). During operation, the oil volume change is compensated by elastic corrugated tank walls. The corrugated walls are made of thin steel foil – as a consequence, the walls are sensitive for mechanical stresses. That is why during transportation and installation of the transformers special attention is recommended. The rules described in chapters “Transport (General conditions)” and “Assembly and commissioning” have to be followed.

Upon Customer’s wish, the transformers can be filled with inhibited oil or ester fluid.

2.1 Related documents

The transformers are manufactured and tested according to standards EN 60076 series. The transformers may be loaded according to IEC 60354:1999.
The transformers are filled with oil according to EN 60296:2012 and PN-90/C-96058. Other national standards (as DIN, BS, CSN, GOST, etc.), mentioned in the transformer test chart, may be applied upon a specific customer request.

MINERA transformers delivered to EU countries fulfil the law requirements covered in the following documents:

- Directive UE 2009/125/EC of the European Parliament.
- Commission Regulation (EU) No 548/2014 of 21 May 2014 on implementing Directive UE 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers.
- Standard EN 50588-1:2014

if law requirement are related to these transformers.

The purchaser receives the following documents from Schneider Electric Energy Poland Sp. z o. o. Mikołowska Fabryka Transformatorów:

- transformer's test report together with the guarantee certificate,
- this manual,
- transformer's overall dimension drawing, if the transformer differs from the catalogue types,
- technical documentation of accessories if their manufacturer provides such,
- other documents agreed in the contract.

2.2 Ambient Conditions

The transformers are designed to be operated both indoors or outdoors; the standard design transformers can be placed at sites of a temperate climate and an altitude of up to 1000 m above the sea level.

The ambient temperature: from -25°C up to +40°C, with 24-hour average temperature not exceeding +30°C, and annual average temperature not exceeding +20°C.

On a specific request, we can provide a transformer for other conditions than the above. These conditions would be specified in a rating plate and in a test report.

3. Special designs

Transformers of MINERA type can be manufactured as dual voltage ones, for two different rated voltages of the electric network. Setting the HV of the transformer can be performed only in off-voltage state, by means of a voltage switch handle placed on the cover.
Insulation of a dual voltage transformer is designed for the higher of the two rated voltages.

MINERA transformers can be manufactured as two winding transformers with additional tap on LV side. This design system can be used when low voltage winding is star connected. Such transformers have two nominal LV voltages. For lower LV nominal voltage, the power of the transformer can be the same as for higher nominal voltage or can be limited. We carry out separate tests for both the combinations of winding in our testing bay: HV – LV full winding and HV – LV tap winding, resulting in two separate test reports being delivered with such transformers.

MINERA transformers can be designed as 3-winding transformers – with two LV windings, electrically separated. This kind of transformers is mainly used in solar farms or for supply of DC networks.

Upon special request we can deliver transformers for rectifier or convertor applications. These transformers have a specially designed electro-magnetic circuit.

4. Basic Accessories

4.1 Tap-changer

Adjustment of the voltage may be performed in off-voltage state only. The range of adjustment is specified in the rating plate. Respective taps are set by rotation of the tap changer head’s handwheel, or by rotation of the tap changer’s head itself, see the Fig. 1 below. Before changing a tap, the head should be unlocked by unscrewing the head lock or by raising the head. Once the setting is done, the head should be locked back.

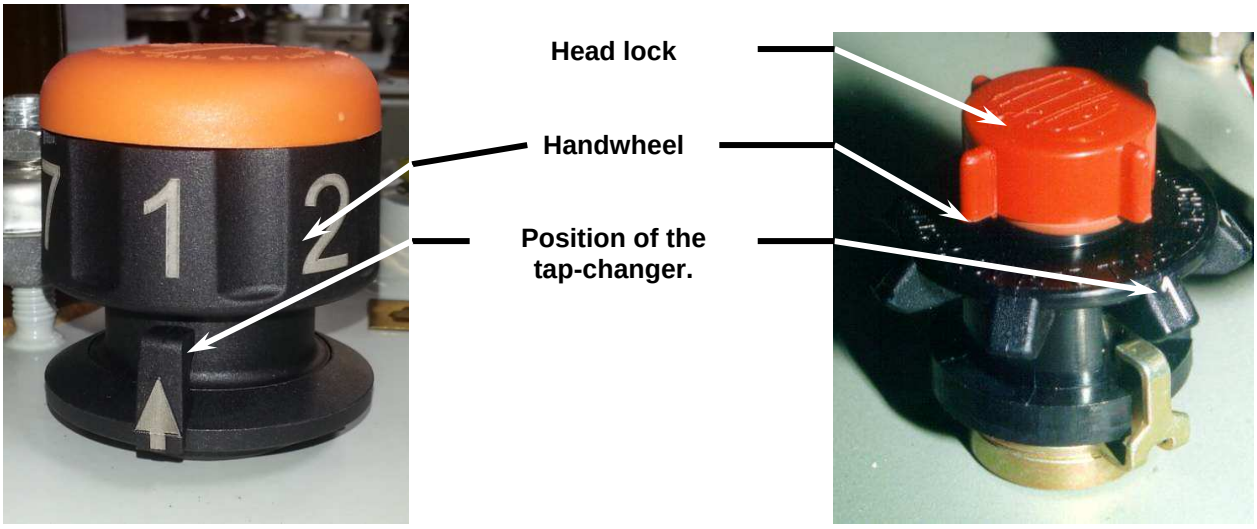


Fig. 1. Tap-changer head.

Digits shown in the head casing's gaps, or shown by the handwheel's indicator, refer to the current position of the tap changer. The digit 1 refers to the maximal amount of HV switched-on turns and the remaining digits concern consecutively decreasing amounts of switched-on turns of the HV winding.

Voltage selector – for double-voltage transformers only.

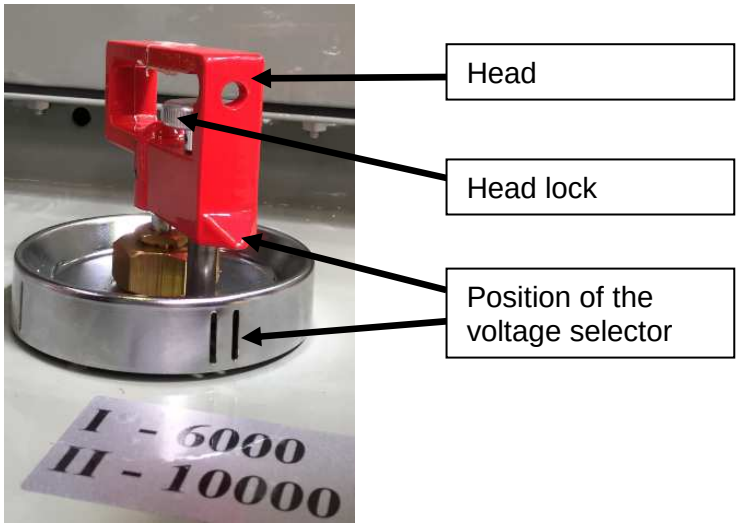


Fig. 2. Head of a voltage selector, execution 1 – side view.

The respective voltage of the double-voltage transformer is selected by means of the head rotation, as shown in the Fig. 4 above.
The mark I or II, shown on the head, indicates a respective voltage according to the rating plate.

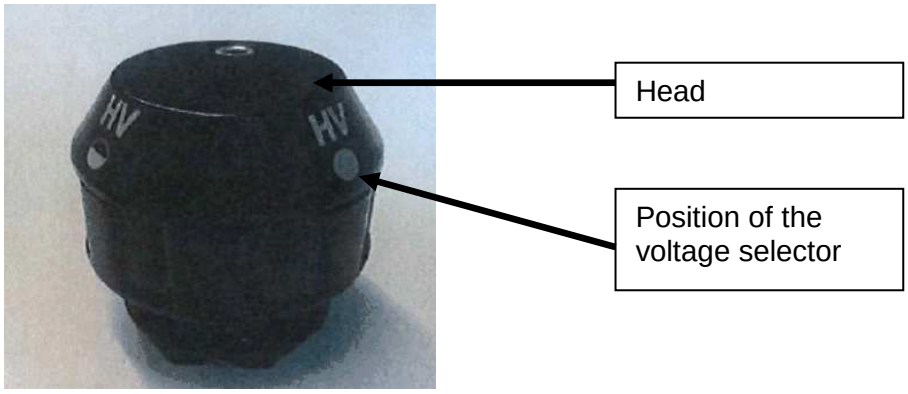


Fig. 3. **Head of a voltage selector, execution 2 – side view.**

The respective voltage of the double-voltage transformer is selected by means of the head rotation, as shown in the Fig. 6 above.
The mark ● shown on the head, indicates a higher supplying voltage setting, according to the rating plate data.
The mark ◡ shown on the head, indicates a lower supplying voltage setting, according to the rating plate data.

4.2 Rating plate

Each transformer is equipped with a rating plate fastened to the transformer body. Upon client's request the transformer can be equipped with an additional rating plate, enclosing the same data, fastened on the opposite side of the transformer. For special designed transformers – for instance, 3-winding or dual voltage ones – two, individual rating plates can be applied, enclosing data unique for different winding combinations. Such two rating plates are generally placed right next to each other.

Rating plate encloses all main data related to the transformer. Data range is in accordance with requirements of EN-60076-1. For transformers intended to be used inside EU, data range is also in accordance with Commission Regulation (EU) No 548/2014 of 21 May 2014 on implementing Directive UE 2009/125/EC of the European Parliament and of the Council with regard to small, medium and large power transformers and with EN 50588-1:2014 standard.

4.3 Lifting device

Each transformer is equipped with 2 lifting lugs placed on transformer's cover. These lugs have to be used when the transformer is lifted by crane. The transformer should be hung in such a way that the angle between crane chains is 60°, or less.

4.4 Filling hole.

Each transformer is equipped with a filling hole placed on the transformer cover. Filling hole can have a form of a pipe with a threaded ring. Completion of filling the transformer with oil is followed by closing this threaded ring by a plug or by a relief valve – see Optional accessories.

Fig. 4. View of a filling pipe with a relief valve.

4.5 Chassis – with or without rollers.

Each transformer – unless agreed different in a contract – is equipped with a chassis consisting of two beams. Four wheels can be fixed to these beams by nuts tightened over the wheels' bolts. These wheels are intended for transformer transportation in short distances only, i.e. for transformer placement inside a transformer chamber. Transportation of a transformer using these wheels is forbidden over longer distances. The wheels can be rotated horizontally by steps of 90° between preset positions, allowing transformer movement along or crosswise transformer longer side axis. For transport on truck purposes, wheels are usually fixed either horizontally or even upside down to the upper side of the beams or to the bottom of the tank. They must be detached and fixed back vertically beneath the beams prior rolling a transformer on them.

Chassis beams are equipped with special holes – pulling lugs – which are intended for pulling the transformer into a transformer room with ropes.

4.6 HV bushings.

The transformers are equipped with one of the following types of bushings:

Porcelain bushings - in accordance with DIN 42531 or EN 50180:2010. These bushings are suitable for outdoor and indoor applications for transformers filled with mineral oil or with other insulation liquid.

The points of contact of nut and threaded pin of each bushing are marked with dots of red paint in order to ensure the bushings remain fastened with factory torque.

Fig. 5 HV bushing according to DIN 42531 or EN 50180:2010

Used types of porcelain bushings are listed in the table below.

No.	DIN 42531 / EN 50180:2010
1	DT 10/30
2	DT 10/60
3	DT 10/250
4	DT 20/30
5	DT 20/60
6	DT 20/250
7	DT 30/30
8	DT 30/60

Porcelain HV bushings can be equipped with terminals for easy making of line connections.

Connector type of bushings: with inner connection type and outer connection type.

a) b)

Fig. 6 Connector type of bushings according to standards:
a) both: EN 50180:2010, EN 50181:2010 and DIN 47637,
b) EN 50180:2010 (Euromould)

4.6 LV bushings.

Transformers produced by Schneider Electric Energy Poland Sp. z o. o. are equipped with LV porcelain bushings according to DIN 42530 or EN 50386:2010. They are suitable for outdoor and indoor applications for transformers filled with mineral oil or other insulation liquid.

The points of contact of fastening parts of each bushing are marked with dots of red paint in order to ensure the bushings remain fastened with factory torque.

Fig. 7. LV bushings according to DIN 42530 or EN 50386:2010 with flat terminals.

LV porcelain bushings can be equipped with flat terminals to make external connections easier. Below table lists the LV porcelain bushings in use, together with terminals dedicated to them. Additionally some types of terminals can be equipped with insulation protections. Types of delivered terminals and insulation protections are specified in a contract.

No.	Type of bushing	Types of terminals in use.
1	DT 1/250	MK1; MK2; type TOGA, type Pfisterer, without terminals
2	DT 1/630	MK1; MK2; type TOGA, type Pfisterer, without terminals
3	DT 1/1000	MK1; MK2; type TOGA, type Pfisterer
4	DT 1/1250	MK1; MK2; type TOGA, type Pfisterer
5	DT 1/2000	DIN standard
6	DT 1/3150	DIN standard
7	DT 1/4500	DIN standard

Busbar bushings according to EN 50387:2009 standard are available for special applications; these bushings are suitable for outdoor and indoor applications for transformers filled with mineral oil or with other insulation liquid.

Fig. 8. LV bushings type „busbar" according to EN 50387:2009

4.8 Earthing terminals

Each transformer is equipped with minimum two earthing terminals M12 placed diagonally on transformer's chassis. Transformer's cover is electrically connected with tank by a special screw, which is assembled instead of one of the regular screws fixing the tank with the cover. If transformer is equipped with connector type of bushings then additional earthing terminals are placed on the cover for cables earthing.

5. Optional accessories.

5.1 Oil level indicator.

Oil level indicators – depending on their manufacturer – can differ in dimensions and in their overall appearance, can also be equipped with additional metal protection shield against mechanical damages, but generally they all share a common construction. Most common type has been shown in a photo below.

The oil level gauge is made of materials resistant to mechanical damages.

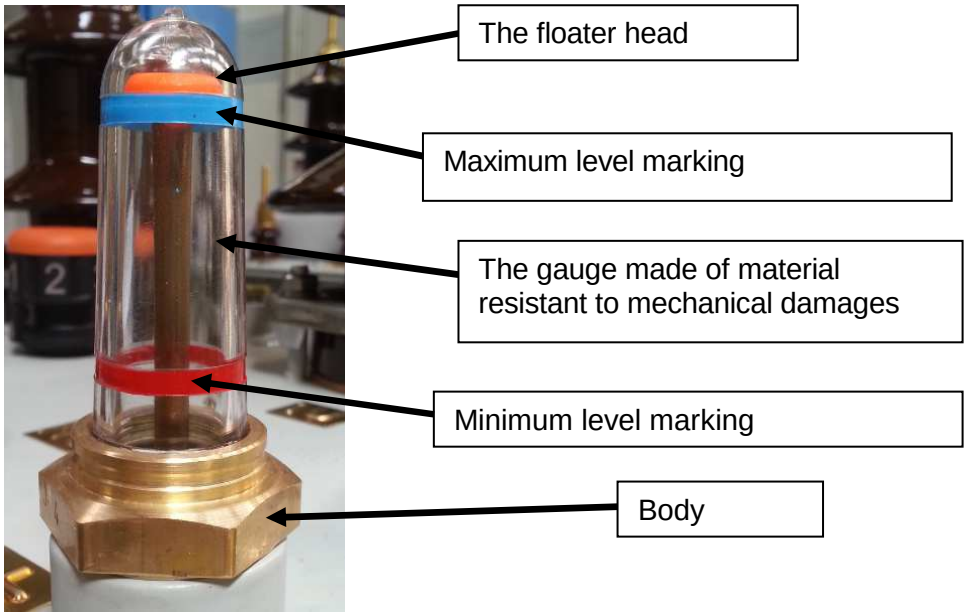
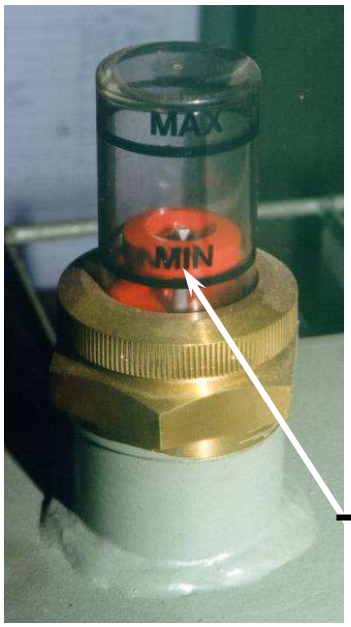


Fig 9. Oil level indicator.

The red floater head should indicate the maximum level (should not descend below the blue line or the line marked with the "MAX" sign)

Operation of a transformer with a lowered level of oil is however allowed to a certain degree. The floater head mustn't under any circumstances descend below the red line of the oil level gauge or below the line marked with the "MIN" sign.



Rys. 11. Oil level indicator in additional metal shield.

Fig. 10. . The floater head in the minimum position. Operation of the transformer below that position is forbidden.

Operating a transformer with oil level lower than indicated by the red line or the “MIN” line is forbidden and can lead to transformer damage.

Connection point between the oil level indicator and filling pipe is marked with a warranty sticker. Unscrewing the oil level indicator is prohibited, can lead to de-hermetization of the transformer and causes an immediate warranty loss.

Oil indicator gauges of brand new transformers are filled with air and an oil surface can often be seen inside. This is often misinterpreted by users as a defect, whereas it is a natural condition resulting from the manufacturing process. Air stuck inside the gauge gradually dissolves in oil within the first few weeks (or even months) from the transformer manufacturing date. Gradual ascending of the oil surface inside the gauge can be observed during this period until the entire gauge becomes completely filled in with oil. It is therefore essential to have in mind that the actual level of oil inside the transformer can be deducted exclusively from the position of the floater’s head.

Caution: If, despite of high resistance to strokes, the gauge of the oil level indicator becomes mechanically damaged, operation of the transformer is forbidden, until the oil level indicator is replaced with a new one and the transformer properly re-hermetized. Oil level indicator’s gauge fully filled with oil does not indicate transformer damage, as long as the oil level indicator itself remains undamaged.

5.2 Oil drain valve

There are two sizes of oil drain valves in use: A22 and A31. Overall dimensions of these valves are in accordance with DIN standard. The drain valve is used in the manufacturing process during filling the transformer with oil and during the transformer tightness test. The transformer users should use the valve solely for draining the oil after the transformer has been damaged and/or when preparing the transformer for utilization. In normal operation, there not only is no need, but it is also forbidden to open this valve, as doing so can lead to de-hermetization of the transformer. The drain valve is marked with a warranty sticker, breaking which leads to an immediate warranty loss.

5.3 Thermometer pocket

There are two types of thermometer pockets in use, with dimensions ¾’’ and 1’’. Dimensions of pockets are in accordance with DIN. The dimensions ¾’’ and 1’’ refer to thread size of a thermometer

which can be assembled in the particular pocket. Transformers equipped with no thermometer have their pocket closed with a plug.

5.4 Thermometer

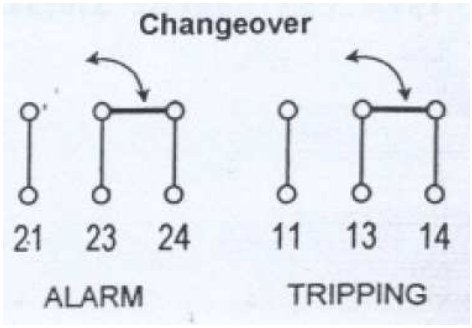
The thermometer is supposed to be mounted in a thermometer pocket. A typical thermometer has an indicator showing current oil temperature, a drag indicator showing maximum temperature and two sets of contacts triggered by overcrossing two various limit temperatures:

- the first limit “ALARM”
- the second limit “TRIPPING”

It is recommended to set limit temperatures as described in chapter „Loading of the oil-immersed transformers”.

Fig. 12. Typical appearance of a thermometer placed in a thermometer pocket.

Fig. 13. Typical diagram of thermometer contacts.



The diagram of contacts can differ from the typical one – it depends on the thermometer manufacturer. The diagram is placed always inside the thermometer casing and should be followed while carrying out the auxiliary wiring.

The following recommendations must be followed, while assembling a thermometer:

- The thermometer pocket has to be filled in with a machine or a transformer oil , ensuring a good transmission of heat between the transformer and the thermometer sensor,
- The thermometer pocket has to be filled in with oil up to the level of 2/3 of the height of the pocket. Excessive amount of oil must be removed, as it creates risk of an oil leakage from beneath the thermometer’s gasket. Shortage of oil should be supplemented in order to keep good temperature transmission.

5.5 Temperature measurement – PT100 sensor.

The temperature sensor is supposed to be mounted in a thermometer pocket, just like a regular thermometer, with respect to the same recommendations regarding the amount of oil in the pocket. The sensor’s resistance changes linearly together with temperature changes of the transformer oil. Reading of this resistance can be transferred outside of the transformer chamber – for instance, into the controlling room. The sensor can be two or three wires type.

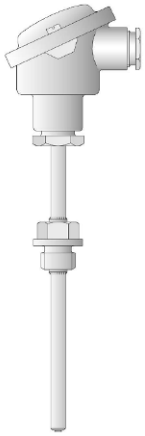


Fig. 14. Typical appearance of a PT100 sensor.

5.6 Integrated protection relay.

The integrated protection relay can guard a transformer against excessive temperature and pressure rises as well as against presence of excessive amount of gasses (including air) inside the transformer. There are two protection relays in use: DGPT2 and DMCR. These relays are manufactured by two different producers but their protection system is the same.

Fig. 15. Views from the left: DGPT2 seen from the oil level protection side, DMCR - general appearance, DGPT2 inside view during wiring.

The protection relay is equipped with a pressure sensor, factory set for pressure limit of 200hPa. This setting should not be changed as it represents the highest admissible pressure value, never to be exceeded in normal operating conditions of a transformer.

The protection relay includes also two temperature relays intended for triggering at “ALARM” and “TRIPPING” temperature thresholds. These thresholds are adjustable and it is recommended to set them as described in chapter „Loading of the oil-immersed transformers”.

The relay is equipped also with an oil level sensor – this sensor is activated when a critical amount of gas (or air) appears inside the relay. Each protection relay has a sampling valve on its top. Opening

this valve while the transformer's temperature is above 20°C will result in an oil spill out of the transformer. Opening this valve while the transformer's temperature is below 20°C will result in air suction into the transformer, which will also trigger a tripping signal due to presence of air. Due to these factors it is forbidden to open, just as it is forbidden to de-hermetize the transformers in any other manner. The sampling valve is protected with a warranty sticker, breaking of which causes an immediate warranty loss.

It is forbidden to open the sampling valve without an individual permission of the manufacturer

5.7 Protection shields against birds.

Protection shields against birds are securing the transformer against short-circuit with arc on HV bushings, caused by big birds. Appearance of such protections on the transformer is shown on the Figure below.

Fig. 16. Protection shields against birds.

5.8 Capacitor for reactive power compensation of no-load current.

Capacity of the capacitor is matched with reactive power of no-load current based on measurement of no-load current carried out on the transformer manufacturer's test field. The capacitors are connected to LV terminals. Appearance of a typical capacitor is shown on the Figure below.

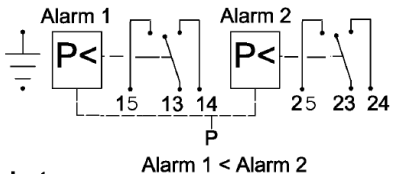
Fig. 17. Capacitor installed on the transformer.

5.9 Sensor of tank internal pressure.

This pressure sensor can detect pressure rise inside the tank, resulting from a slow development of the transformer damage. This sensor should not to be applied simultaneously with a relief valve.

Fig. 18. Pressure sensor - AKM type.

Fig. 19. Pressure sensor – typical connection diagram.



5.10 Relief valve

The relief valve is an additional protection against results of transformer overloads. Once the internal pressure inside a transformer tank reaches the valve's threshold, the valve opens and releases the excessive amount of oil, reducing internal tank pressure and protecting the tank against damage. This valve opening can be observed only during a very high transformer overload – overload much higher than permissible. The valve opens when internal pressure reaches the threshold of 250 hPA (–0% +20%). As soon as the pressure drops, the valve closes itself. The valve needs no maintenance, nor regulation. It is protected by a plastic or metal shield in red colour. This shield avoids accidental opening of the valve, which would lead to the transformer de-hermetization. The red shield is marked with one, or two warranty stickers. Breaking any of those stickers causes an immediate warranty loss.

5.11 Cable boxes – LV and HV.

Cable boxes are generally designed within direct settlements with the client. Their purpose is to screen either the LV bushings, the HV bushings or both the LV and the HV bushings. The dimensional drawing of a transformer with a box is most often a subject of approval by the user. It is enclosed in the documentation delivered to the client.

5.12 Less common optional accessories.

The following additional accessories can be used:
- Oil level indicator with additional contacts,
- Thermometer with additional contacts,
- Protection of hermetization,
- Box with transmitter for conversion of PT100 signal to analog signal processing (a manual of the transmitter is placed inside the box).
- Marshalling boxes for auxiliary circuits – for instance for signals from the thermometer and the oil level indicator etc.
- Safety valve,

The relevant technical documentation delivered by manufacturers of additional equipment should always be respected.

6. Hermetization process

The transformers are hermetized (air tight sealed) in the factory at a temperature of ca 293K (20°C). At this temperature, the inner pressure of hermetized transformers is equal to the atmospheric pressure. During the transformer operation, oil in the transformer changes its volume, resulting with either an increase or a decrease of the pressure inside the transformer tank. Changes of oil volume are intercepted by flexible corrugated walls of the transformer tank. De-hermetizing the transformer is forbidden and lead to an immediate warranty loss.
After the warranty has expired, de-hermetizing of the transformer should be carried out only at the manufacturer's workshop, or at a workshop featuring an appropriate knowledge and facilities to perform correctly such an operation.

7. Transport (general conditions)

The transformers may be transported by rail or road transport. At the destination, the transformers can be handled by means of cranes or any other adequate lifting devices. Hauling the transformers on their wheels is admissible only at very short distances, on flat, hard surfaces only.

The transformers should be protected against any mechanical damage during transport and handling. Special attention must be paid to secure the transformers against shifting on the transport means floor (i.e. truck floor). Fastening belts should be used to fix the lifting lugs on the transformer cover and/or the lugs under the corners of transformer's tank, with lugs in the floor, while the transformer itself must be placed on a pallet or its chassis restrained to the floor by use of wooden beams.

In a vertical transport, the transformer may be lifted only using lifting lugs, placed on the transformer cover, designed strictly for this purpose. It is strictly prohibited to lift the transformer by pulling the peripheral rod linking the tank radiators or the lugs beneath the cover corners. These lugs are intended only for fastening the transformer to the truck floor lugs. Transformers should be protected against any shocks, strokes, crumps, hits, etc.

Only small transformers can be loaded on a truck or unloaded from a truck using a fork-lift. Those transformers' chassis are labelled with a pictogram showing, that this kind of lifting is allowed.

Some transformers (with big overall dimensions) are equipped with an additional protection system against radiators damage (Fig. 20). The system consists of 4 beams assembled horizontally around the transformer and suspended on vertical rods keeping those beams in right position.

Fig. 20 Protection system with beams for transport purposes.

The protection system should be disassembled after installing the transformer at its destination. It is however admissible to keep the protection system on, having in mind, that it some cases it may increase the transformer's noise level. In any case, it is essential to keep the protection system to be used in case of future transformer relocation. Transformers delivered with such protection system cannot be transported without it under any circumstances.

Warning: ***It is strictly forbidden to step on the transformer's peripheral rod linking the tank radiators or on the transport protection system beams.***

All service and maintenance works have to be carried out with proper care. Transportation and installation works should be done in such a way that any risks of additional equipment damages are excluded. Equipment damages can cause transformer de-hermetization and warranty loss.

It is highly recommended to carry out a visual check of each transformer upon its reception. Such visual check should be focused on possible transportation damages as well as condition and presence of accessories. Any non-conformities noticed upon transformer reception have to be recorded in the transport documentation, which will be a base for assessing of the merits of complaints.

Each transformer is protected with warranty seals (stickers or dots of red paint); breaking these seals can lead to warranty loss.

8. Storage conditions and requirements

Transformers in storage should be protected with respect to the following guidelines:

a) Transformers should be stored being completely assembled,

b) Protection of transformers in storage should be the same as of those being in operation,

c) Transformers in storage should be subjected to a detailed visual inspection and periodic measurements once a year, just like transformers being in operation.

d) Transformer storage location should be protected against access of any unauthorised personnel.

9. Assembly and commissioning

9.1. Inspection of a transformer

Transformer assembly should be preceded with a thorough examination of the transformer. The following must be carried out in particular:

a) Visual inspection of the transformer, paying special attention to whether the transformer tank, bushings, oil level indicator, etc., do not suffer of oil leakages and/or mechanical damages caused during handling or storing.

b) Any damage of lacquered surfaces should be protected against corrosion by re-painting.

c) Oil level check (in transformers equipped with an oil level indicator)

d) Bushings spark gaps adjustment check (does not apply to transformers equipped with connector bushings). Insulating gaps should be as follows:

up to 12 kV	- without horns
above 12 kV up to 17.5 kV	- 90 mm
above 17.5 kV up to 24 kV	- 120 mm
up to 25 kV	- 150 mm
above 25 kV up to 30 kV	- 200 mm
up to 38.5 kV	- 220 mm

9.2. Setting up the transformer at the site

The transformer should be set up at a site already prepared for this purpose. The site should comply with the following requirements:

a) Transformers are designed to be set up on platforms or steel structures, or inside switching stations, or hanging on poles (special design for this purpose),
b) Transformer's base should be horizontal, with accuracy of ± 3°,
c) The transformer set up at its site should be protected against shifting and any change of its position.

If the transformer is placed in a transformer chamber, the chamber has to fulfil good ventilation and appropriate distances requirements.

Room ventilation

The room in which a transformer is to be installed, should have a ventilation sufficient enough so that the heat produced by the transformer does not warm the room up to a temperature exceeding conditions specified in point 4 of herein manual. Sufficient ventilation is, in most of the cases, provided by air intake and exhaust grilles situated in walls of the transformer chamber. Forced ventilation should be implemented in case of doubts about the efficiency of room's ventilation. It should be taken into account that an air flow of 180 m^3/h per each 1 kW of transformer losses is needed to ensure good ventilation of the chamber.

Ventilation grilles should be located on the opposite sides of the chamber. The intake grille should be placed near the bottom of the chamber, while the exhaust grille, near the ceiling. Surface areas of the grilles may be calculated with the following formulas:

$$S1 = 0.18 \times \frac{P}{\sqrt{H}} \qquad S2 = 1.1 \times S1$$

Where:

S1 surface of intake grille [m^2]
S2 surface of exhaust grille [m^2]
P total losses of transformer (sum of load losses at 120°C and no-load losses) [kW]
H height difference between grilles axis (intake and exhaust) [m]

Setting a transformer in place (distances)

Transformers should be placed at proper distances from room's walls in order to provide good insulation and ventilation levels, as well as free space for staff.

Minimal distances between parts under voltage and walls or earthed elements should be in accordance with the following table:

Voltage level [kV]	Distance between parts under voltage and walls or earthing elements [mm]
7.2	100
12.0	150
17.5	200
24.0	250
36.0	350

If there are two or more transformers located in one transformer chamber, the distances between the transformers should not be lower than 250 mm.

9.3. Assembly works

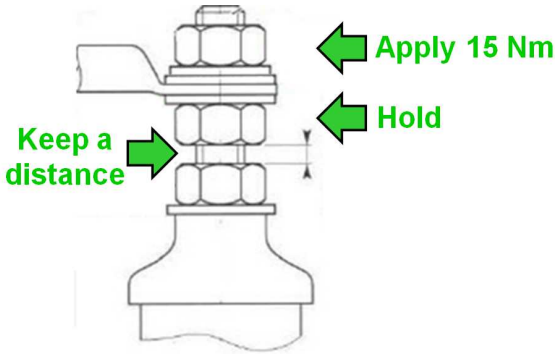
The following rules have to be applied during the assembly works:

- It is forbidden to stand or walk on the: radiators, peripheral rods reinforcing the radiators, cover of the transformer and beams reinforcing the tank during transportation.
- Only a free-standing stepladders or platforms should be used – it is forbidden to lean a regular stepladder against the transformer (especially against its radiators).

The following operations should be carried out in the given order:

a) Earthing the transformer tank using earthing terminals. The connection should be firm and protected against loosening and/or corrosion. The neutral earthing (of the LV network neutral point) should be separated from the protective earthing.

b) Connecting the LV and HV outputs. The top nut of the HV bushing (supposed to tighten the cable head to the bushing) should be tightened with a torque not greater than 15 Nm. Clockwise tightening of this nut with a torque wrench should be accompanied by holding the middle nut with a regular flat spanner. Caution must be paid not to twist the brass bolt of the bushing, as it vulnerable to damages due to an excessive torque. A distance must be kept between the middle and the bottom nuts. The bottom nut is marked with a warranty seal, made of a red lacquer dot.



Output connections (cables or bars) should be as short and stiff as possible and yet made in such a way that they do not apply any breaking force to the bushings. They should be tightened firmly and protected against accidental loosening.

The LV connections should also be done in such a way that there is a distance between the sealed bottom nut of the bushing and the middle and top nuts tightening the cable head (Fig. 21) or distance between the sole nut and the flat terminal (Fig. 22).


Fig. 21


Fig. 22

Connecting external bus-bars to flat terminals is supposed to be done by screws made of stainless steel or steel covered by hot-dip galvanizing. Recommended torques (to be applied to the nuts) are shown in the table below.

Recommended torques

Size of the screw	Torque for steel screws [Nm]
M8	20
M10	40
M12	70
M14	100

c) Earthing of the LV network neutral point.

d) Connecting the protecting devices.

e) Removal of transportation protections (if any) of the transformer, radiators and optional equipment.

Warning: ***HV porcelain bushing nuts made of copper or brass should be tightened with torque not greater than 15 Nm. An excessive torque can damage the bushing.***

Operating a transformer with its bushing/s damaged is not allowed and can lead to further transformer damages.

Flat terminals have to be used on the LV side connections, whenever the transformer is equipped with such terminals.

9.4. Preparation to twitch the transformer on

a) Set the tap-changer and the voltage switch (the voltage switch applies to double-voltage transformers) according to the actual operating conditions of the transformer.

Attention: The permanent operating voltage on any of the taps mustn't exceed the 1,05 value of the given tap's nominal voltage.

b) Check the resistances of the neutral and protective earthings.

c) Check whether the fuses (if used at all) have been selected properly.

9.5 The first switching-on

Prior switching the transformer on, check whether all the instructions specified in the chapter 9 (sub chapters 9.1 to 9.4) of herein manual have been followed. In case the transformer is intended for a parallel operation, additional requirements for a parallel operation must be met:

a) Conformance of the rated primary and secondary voltages,
b) Conformance of the taps of the transformers planned for a parallel operation,
c) Conformance of the vector groups,
d) Conformance of the short-circuit voltages (accuracy of ±10% in relation to the average value)
e) The transformers' power ratio should not exceed 3:1.

Once the above checking procedures have been completed, the transformer may be switched on.

Switching a transformer on is followed by presence of a short-term, very high current supplying the transformer. The value of this current can be a dozen times higher than a nominal current's value. Presence of this current has to be taken into account while setting the protection devices, for instance, by proper adjustment of the protection's characteristic, or by activating the protection with a 0,5 second time delay.

The transformer should be immediately switched off and control measurements and inspection should be carried out in case any abnormal operation symptoms, e.g. unusual noise etc. are observed after switching the transformer on. In case the transformer has been switched off because of safety reasons, it may be switched on again only if the reasons of its switching off have been found and removed.

10. Operating the transformer

Transformers need periodical inspections regardless of whether they work in stations with a permanent staff presence, or in stations with no permanent staff presence. Results of these inspections should be recorded in a manner determined by the site management.

Recommended frequencies of the inspections are as follows:

a) Inspection of a transformer without its de-energizing, at a station with a permanent staff presence - once a shift.
b) Inspection of a transformer without its de-energizing, at a station without a permanent staff presence - once every 5 years.
c) Periodical inspections, including transformer de-energization – not required.

10.1 Inspection without transformer de-energization

The following aspects should be checked in particular during inspecting a transformer without its de-energization:

- Load level with respect to an even spread of load across the transformer's phases.
- Oil level indicator's floater position, and transformer tightness.
- Condition of the bushings
- Conditions of bus-bar and cable connections
- Level of surface pollution of bushings, additional equipment, tank and cover.

10.2 Control measurements.

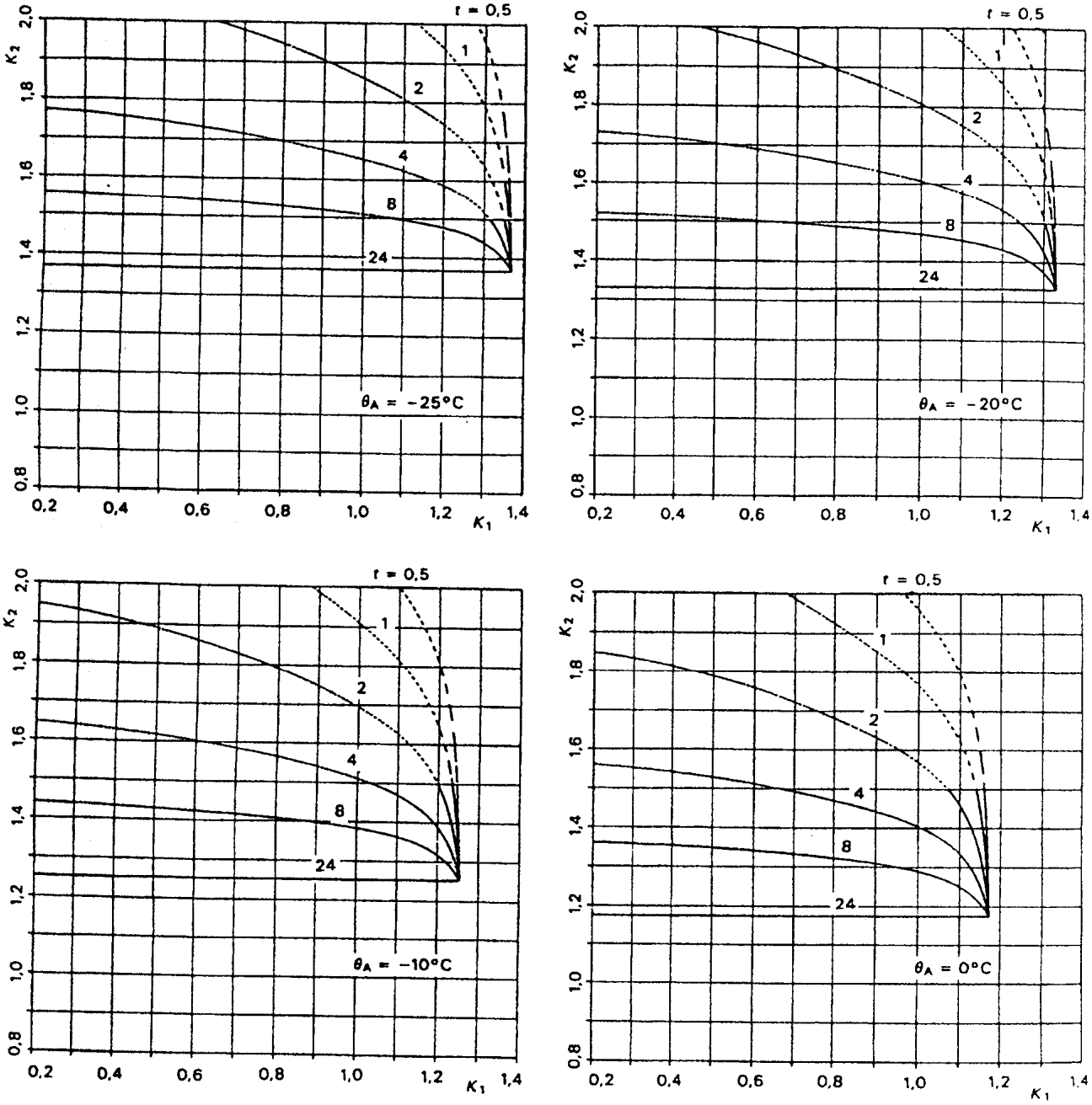
Control measurements are not required.

11. Oil-immersed transformers load principles

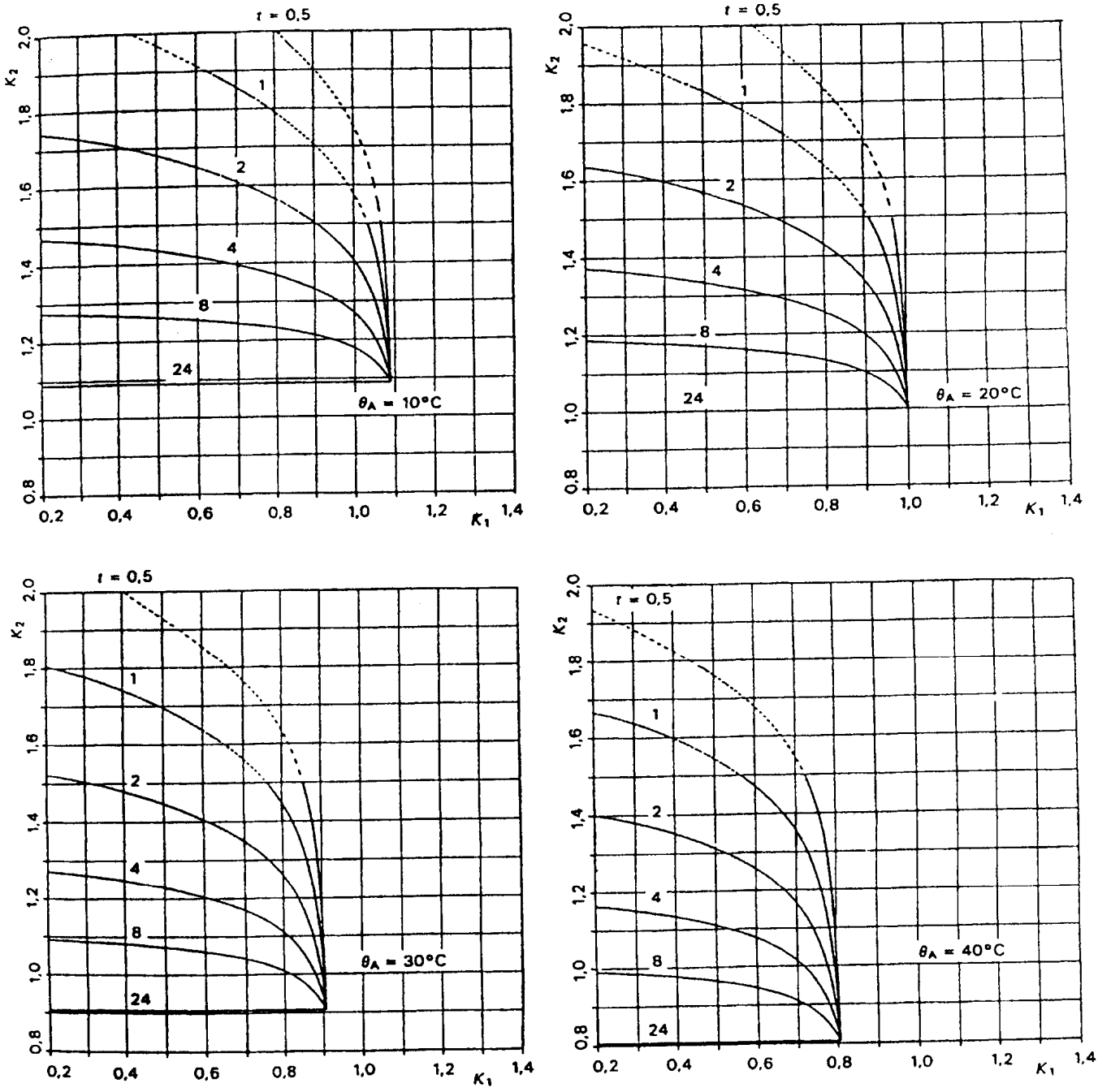
The estimated life-time of distribution transformers working at their rated load and at the ambient temperature of 20°C is minimum 20 – 30 years. In reality however, the transformers are being operated at loads both lower and higher than the rated ones.

The rules of loading the transformers depending on the operating conditions, while sustaining the defined operating temperature and thermal ageing of the insulation are included in the IEC 60354 standard: "The guidelines for loading the oil-immersed transformers".

The graphs shown below comply with the IEC 60354 standard. They can be used for defining the maximum peak load **K2** for the given time and the given initial load **K1** for distribution transformers at eight different ambient temperatures.



ONAN distribution transformers – maximum admissible loads at regular life-time expectancy



ONAN distribution transformers – maximum admissible loads at regular life-time expectancy

If the transformer is equipped with a thermometer, it is recommended to use this thermometer to monitor the transformer overloads. The thermometer is equipped with 2 sets of contacts reacting when 2 various temperature thresholds are exceeded:

- The first “ALARM” threshold - reaching this temperature limit means, the temperature of nominal insulation ageing has already been exceeded. The transformer can still operate, but its insulation ageing will be faster, than nominal.

- The second “TRIPPING” threshold - reaching this temperature limit means, that the transformer should be switched-off immediately, as its further operation may lead to transformer damage.

It is recommended to set the temperature thresholds as follows:
- “ALARM” the first threshold - set on 85°C,
- “TRIPPING” the second threshold - set on 95°C.

Lower values may be set upon the user’s needs, yet it is forbidden to set values higher, than those above.

12. Spare parts

The Schneider Electric Energy Poland Sp. z o. o. Mikołowska Fabryka Transformatorów Company supplies spare parts under the rules agreed with the Customers. Spare parts queries must enclose the subject transformer’s serial number.

13. Complaints

In case the User has not followed the principles and/or instructions specified in the herein manual, and/or a transformer damage has been caused by an improper transportation, handling, storing, or using, and/or the warranty seal has been damaged or removed (including also the red lacquer dots placed on the bushings), the manufacturer is free from any liability and/or warranty obligations whatsoever.

Complaints should be raised in a written form, only during the warranty period and immediately upon detection of the non-conformity being the subject of complaining.

A written complaint should enclose the following:

- The protocol of tests and measurements carried out during transformer commissioning,
- Transformer’s warranty card,
- Detailed description of the damage,
- Basic data, including at least the type and the serial number of the transformer, location of the transformer at the moment of non-conformity detection, current location of the transformer (if different), transformer commissioning date and failure (or non-conformity detection) date.
- Photo documentation of the transformer and its damages (if visible)

Phone: +48 32 7728 320 (Monday till Friday, 8:00 a.m. – 16:00 p.m. CET)
Mobile: +48 605 726 028 (Monday till Friday, 8:00 a.m. – 16:00 p.m. CET)
E-Mail: serwis.mikolow@schneider-electric.com

No repairs are permitted, unless the manufacturer (Schneider Electric Energy Poland Sp. z o. o. Mikołowska Fabryka Transformatorów) authorizes the User to proceed, or a service engineer authorized by the manufacturer arrives at the site. Every claim is a subject of an individual assessment and the resolution manner is dependent on the nature of the damage and the User’s needs. The factory service offers:
- Visual inspection at the site,
- Small repairs at the site,
- Transformer transportation to the factory (without de-installation and installation works at the site)
- Transformer repairs in the factory
- Small repairs at the site, carried out by an authorised third party companies.

Unless it is defined in the contract, the manufacturer does not organize, nor cover the costs of transformer de-installation and installation, internal transport at the Customer's site, spare transformer, spare power supply, as well as loading and unloading the transformer on/from the truck.

14. Utilization of transformer, dangerous materials

Transformers produced by Schneider Electric Energy Poland Sp. z o. o. do not include dangerous materials in accordance with a directive RoHS 2002/95/WE (lead [Pb], cadmium [Cd], sexivalent chromium [Cr], PBB and PBDE). Utilization or storage of transformers or their parts after their life-time expiration should be carried out in accordance with RoHS 2002/95/WE.

Oil immersed transformers are made of the following materials: steel, copper or aluminium, cellulose insulating materials, paper, artificial materials, mineral oil or insulation liquid based on fatty acid esters, porcelain and rubber. From the environmental point of view the oil is the most dangerous among all the materials mentioned above. Special attention must be paid to avoid soil and ground waters pollution with oil. The utilization process may be entrusted to a licensed and experienced company that specialises in this type of operations. Oil must be removed out of the transformer's tank and handed over to a specialised collection point. Incinerating a transformer oil is strictly prohibited unless carried out in an adapted installation fulfilling special requirements.

Insulation liquid based on fatty acid esters does not menace the environment and its biodegradation period is fast. This liquid is therefore approved for use in biologically sensitive areas.

Disassembled transformer metal parts do not contain dangerous materials and can be utilised as a regular steel scrap.

It is permissible to recover copper or aluminium from coils. The insulating materials like pressboard and paper however, are saturated with oil and are therefore a dangerous waste. Coils must be handed over to a company which specialize in utilization of this type of materials. The same applies to wooden beams and cork-rubber gaskets.

Porcelain after cleaning is not dangerous for the environment.

15. Additional Information

In case of any doubts, problems, or need for additional information or assistance regarding our transformers, do not hesitate to contact us at:

Schneider Electric Energy Poland Sp. z o.o.
Mikołowska Fabryka Transformatorów
Address: **ul. Żwirki i Wigury 52**
43-190 Mikołów

Phone: +48 32 7728 222
Fax: +48 32 7728 361