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The equipment described in this publication has to be installed, operated and maintained only by qualified and perfectly trained staff, acquainted with all risks related to the operation of such type of equipment.



The Company EGE, spol. s r.o. does not assume any responsibility for damages or losses of any kind, resulting from print errors or modifications of this manual.

Except warranty period, the company EGE, spol. s r.o. also assumes no responsibility for any damage and loss of any kind, resulting from faulty devices or modifications, carried out on devices by user

1. PACKAGE AND TRANSPORT

1.1. SPECIFICATION OF ENVIRONMENTAL CONDITIONS

The environmental conditions for transport must be guaranteed according to *Operating Instruction 7*.

1.2. CHOICE OF TRANSPORT MEANS

Details necessary to choose suitable loading and transport means are given in the Trading and technical documentation of the product (sheet with technical product specifications, dimensional drawing, etc.).

The products shall be always transported in vertical position.

1.3. TRANSPORT UNITS

Arc-suppression coils or combined arc-suppression coils are transported by type either assembled or disassembled into several transport units. Overview of transport units for each type of equipment is shown in Table 1.

Table 1

Type of Transport unit **Type of equipment**	**Assembled equipment**	**Equipment with dismantled conservator**	**Crating with conservator**	**Crating for barrels of oil**	**Crate with bushing D1**	**Crate with accessories** 1)	**Crating with radiators**
ZTC50, 250, 800, 1250	+	-	-	-	-	+	-
ASR1.0(V) ASR1.6 ASR2.0 ASR2.5	+	-	-	-	-	+	-
ASR3.2(V) ASR4.0 ASR5.0 ASR6.3 2)	+/-	-/+	-/+	-/+	-	+	-
ASR6.3V 2)	+/-	-/+	-/+	-/+	-/+	+	-
ASR8.0(V) ASR10(V) ASR12(V) ASR15(V) 2)	+/-	-/+	-/+	-/+	-/+	+	-/+
ZTC 4000	-	+	+	+	-	+	+ 3)
ZTC 5000	-	+	+	+	+	+	-
Coil in corrugated tank	+	-	-	-	-	+	-
ASRC	+/-	-/+	-/+	-/+	-/+	+	-

Explanatory notes:

+ part of supply

- not part of supply

1) Accessory means:
   - Wheels including mounting material (if supplied),
   - Remote indicator and Uo indicator (if ordered),
   - Air dryer (when the device is transported with dismantled conservator),
   - Gaskets needed for assembly of the conservator, dryer etc.
2) Depending on chosen transport you can ship the equipment either complete or with dismantled conservator.
3) This applies only to equipment with radiators.

1.4. HANDLING

The arc-suppression coil (combined arc-suppression coil) may be suspended (and thus transported) only per lifting eyes, hooks and pins, designed for this purpose.

The placement of handling elements and its purpose is always described in technical documentation of products. A typical placement of handling elements is shown in Table 2 and Picture 1.

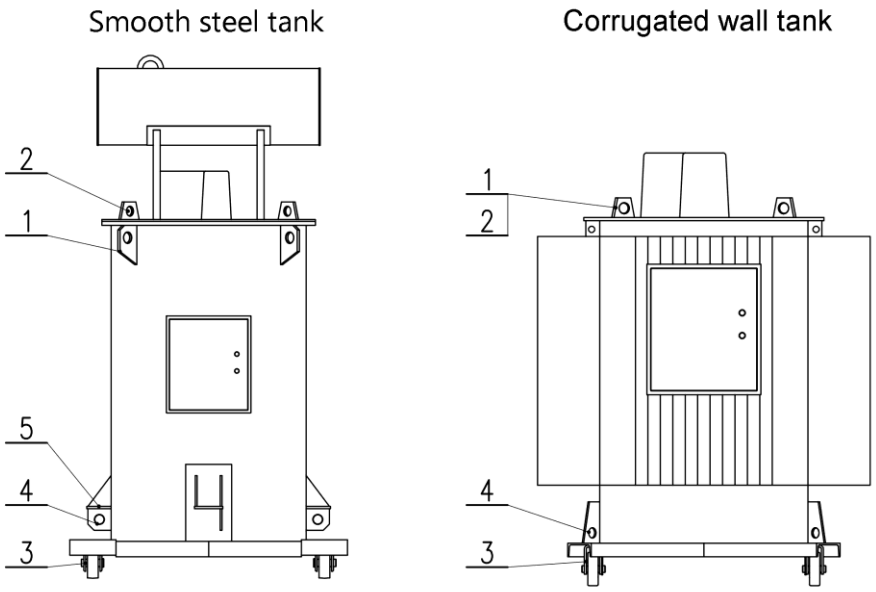
Table 2

Amount	Part	Placement	Purpose
4	Lifting eye (hook, pin)	on tank below the cover	lifting the complete arc-suppression coil by crane and fixation during transport
2 / 4	Lifting eye	on the equipment cover	lifting of removable part [1)]
4	Wheel	tank chassis	transversal and longitudinal travel
4	Towing eye	bottom part of the tank	transversal and longitudinal travel
4	Lifting foot	bottom part of the tank	Lifting the complete coil by hydraulic jack [2)]



1) The mentioned lifting eyes can not be used for lifting of a complete arc-suppression coil, except coil type ZTC 50, arc-suppression coil in corrugated tank and all types of combined arc-suppression coils. Here the eyes on the cover are designed to lift the entire equipment.

2) When lifting the coil by hydraulic jack, all four lifting foots have to be used at the same time.



Picture 1 – Placement of the handling elements on the coil

The length of suspension cables must be chosen so as to avoid mechanical damage to coil parts, such as bushings, conservator, radiators etc. It is also necessary to avoid damage to the surface treatment during handling. Other transport units as crates and crating may be lifted by forklift or crane by cables, passed under the whole transport unit. Crates and crating are not intended to be hung for individual parts of the package, or parts of the product inside the packaging.

The gravity center of arc suppression coils can be located outside the center axis. Therefore it is necessary to load and to handle the device with caution due to possible swinging during the lifting.

The arc suppression coil in corrugated tank cannot be handled in case the ambient air temperature falls below -35°C.

1.5. SECURING THE LOAD DURING TRANSPORT

The transported freight must be placed and secured according to *Operating Instructions 2*. For products designed with air cushion please read the article *Package and Transport* described in *Special Operating Instructions for Arc Suppression Coils and Combined Arc Suppression Coils with Air Cushion* – document ELA T0187.

The device must be properly secured against movement to avoid mechanical damage during transport. Securing must be performed in designated locations (eyes, pins).

1.6. CHECKING OF DAMAGES CAUSED BY TRANSPORT

Upon arrival to the destination place the equipment must be checked for completeness of the delivery according to the Delivery Note. It is also necessary to verify that all shipping units are undamaged and carry out a visual inspection for

tightness of bushings, valves, filling holes etc. In addition it is necessary to verify, whether the surface treatment is not damaged by transportation.

If the delivery is not complete or any fault is found, you must follow these steps:

- Before unloading the freight, do document (photo) the fault which occurred and write a report, where the defect or deficiency is described.
- Promptly notify the supplier.

2. STORAGE

2.1. SPECIFICATION OF ENVIRONMENTAL CONDITIONS

The environmental conditions for storage must be guaranteed according to *Operating Instruction 7*.

2.2. STORAGE OF EQUIPMENT SUPPLIED IN COMPLETE CONDITION

The equipment supplied in the complete condition may be stored indefinitely, if requirements of article 3.1 are observed.

However, where the equipment has an air dryer DIN with desiccant it is necessary to carry out periodic inspections (see *Instructions for the dryer DIN*).

If the device is equipped with a maintenance-free dryer, the dryer must be connected to electric mains (see *Instructions for maintenance-free dryer*) to guarantee the functionality of the dryer and to prevent deterioration of the oil quality.

If a valve is mounted on the connecting pipe, providing oil flow between the tank and the conservator, this valve must be kept in open (operating) condition.

For protection of electric equipment inside the motor-drive control cabinet (water condensation), you need to use a desiccant (transient protection), or to connect (activate) the control cabinet heating according to the wiring diagram of the motor-drive control cabinet (permanent protection).

Assembly of chassis wheels is performed not before installing on-site. To prevent damage to the surface finish of the chassis, the coil should be placed for the duration of storage on a suitable base (wooden planks).

If the crate contains any instruments (remote indicator, indicator Uo), it must be stored in indoor areas with relatively constant environmental conditions, in order to prevent water condensation on those instruments.

2.3. STORAGE OF EQUIPMENT SUPPLIED IN PARTIALLY DISASSEMBLED CONDITION

2.3.1. Storage of fully assembled equipment.

If the equipment has to be assembled before storage, the assembly work depending on the coils design must be done in accordance with Article 3.3. to 3.6. of these General Operating instructions.

Then proceed according to Article 2.2 - Storage of equipment delivered in complete condition.

2.3.2. Storage of partially disassembled equipment.

This kind of storage is not recommended by manufacturer!

If, however, such kind is required by the customer, it is necessary to ask for special accessories when ordering the product. The tank in this case is provided with a provisional shipping part and an air dryer.

Then proceed according to Article 2.2 - Storage of equipment supplied in a complete condition.



If the equipment is stored in a partially disassembled condition, it is necessary when commissioning, to pay more attention to the quality of transformer oil (see "*Operating instructions 1 - Insulating oils*").

3. INSTALLATION ON SITE

3.1. SPECIFICATION OF ENVIRONMENTAL CONDITIONS

The environmental conditions for stationary application must be guaranteed according to *Operating Instruction 7*.

If the equipment is installed in an enclosed space, it is necessary to provide sufficient air circulation (at least $4m^3$ / min air per 1 kW heat loss). Indication of the magnitude of the losses is given in the Trading and technical product documentation (see Test report), which is supplied with the product.

3.2. SITE SPECIFICATION

The plan of the site must be processed in accordance with all related standards.

In particular standards relating to:

- General requirements for electrical substations,
- Requirements for installation site with respect to building regulations, cooling, noise and fire safety,
- Terms of protection against dangerous direct and indirect contact,
- Types of grounding in electrical substations,
- Operating conditions for electrical power systems with compensation of capacitive ground currents,
- Requirements for the protection of electric machines.

Note: To ensure correct operation of the gas relay, horizontal position of the arc-suppression coil is necessary (with maximum tolerance of 1°).

3.3. ASSEMBLY OF RADIATORS

Delivery with removed radiators can be realized only in case of a special and unusual project (separate technological instructions will be passed).

3.4. ASSEMBLY OF CONSERVATOR

If the device is transported in an incomplete state, the conservator is placed in a wooden crating. The flange of the conservator and the gas relay pipe on the coils cover are for transport covered with blanking caps.

The assembly procedure is as follows:

- Remove blanking caps,
- Clean sealing surfaces of flanges on connecting pipes,
- Use rubber gasket, delivered in a box with accessories
- Screw together flange connecting the conservator pipe with gas relay
- Fix conservator to the bracket on the cover (during transport, the necessary screws, nuts and washers are attached on cover brackets),
- Install the connecting pipe between conservator and dryer (pipe transported in crating)

Exception – delivery of an arc-suppression coil with special equipment (see Article 2.3.2). In this case the pipe is element of provisional transport part, installed on the tank of the transported choke.



In the event that before installing the conservator was stored for a longer time (see Article 2.3.2), it is necessary to perform an additional check of condensed water occurrence (by suitable rotation of the conservator and opening of the filling or draining valve) to prevent degradation of transformer oil. If necessary the conservator must be dried. The provisional connection between the flange of the gas relay and dryer must be removed.

Note: The installation of conservator requires appropriate lifting mechanism, e.g. mobile crane. The above mentioned description of the assembly refers to a standard conservator design.

3.5. INSTALLATION OF BUSHINGS

In case of separate transport, the bushing is stored in a separate crate along with the necessary gaskets for installation.

Separate technological installation instructions will be delivered.

3.6. INSTALLATION OF DRYER

If the product is shipped with dismounted conservator and dryer, then the dryer is located in a separate crate with seals needed for the installation.

The installation procedure is as follows:

- Clean the sealing surfaces of the connecting pipe flange,
- Use rubber gasket,
- Attach connecting pipes by clamps to holders on the tank,
- Check the dryer, then follow Operating instructions for the dryer.

3.7. ASSEMBLY OF CHASSIS

Assembly of chassis wheels is carried out before the final installation of the equipment on site. When assembling, proceed as described under *Operating instructions 3*.

3.8. OIL REFILLING - VENTING

In the event that the equipment is delivered partly disassembled, the transformer oil must be refilled immediately after the delivery and assembly. The necessary oil is supplied in individual barrels, which are transported in cratings.

Technical parameters of oil to refill, the process of oil refilling and setting up the oil level in the conservator are contained in *Operating instructions 1*. The venting will be carried out to match the instructions given in the *Operating instructions 5*.



Before venting is necessary to remove rubber inserts from the test button of the Buchholz relay.

4. CONNECTION

The position of bushings and their markings are shown in dimensional drawing of the Trading and technical documentation of the product. According to the marking system used by the customer, the bushings may be marked as follows:

Main winding input bushing – node	D1	1.1	U
Main winding output bushing – ground	D2	1.2	V
Combined coil – main winding bushings	A, B, C	U, V, W	1U, 1V, 1W
Bushings of current transformer	k - l	k - l	k - l
Bushings of measuring winding	M1-N1	3.2 - 3.1	v_m - u_m
Bushings of power winding	M2-N2	2.2 - 2.1	v - u



To the connection of cables to bushings special attention must be paid. Avoid loosening the nut of the bushing bolt that ensures tightness of the bushing and prevents leakage.

4.1. CONNECTION OF BUSHINGS OF THE MAIN WINDING

Electrical connection to the bushings must be sufficiently dimensioned and fixed (supported) enough to minimize the mechanical stress of the bushings.

The connection is performed according to specific technical installation (see Trading and technical documentation) and is carried out by a cable lug, cable plug or terminal. The contact surface must be with smooth and clean, eventually equipped with thin contact vaseline layer.

4.2. CONNECTION OF BUSHINGS OF THE POWER WINDING

Electrical connection to the bushings must be sufficiently dimensioned.

The connection is done by a cable lug or terminal with smooth and clean contact surfaces.

Bushings of the secondary winding are situated on the cover, according to the type, either under a sheet metal cover, or, as ungrounded bushing, under a plastic cover. Specific design can be seen from the Trading and technical documentation.

4.3. CONNECTION OF BUSHINGS OF THE MEASURING WINDING AND OF THE CURRENT TRANSFORMER

Bushings of these circuits are always placed under cover and wired by cables to the terminal block inside the motor drive cabinet. The secondary terminals of the current transformer are short-circuited at this terminal block. In case the terminals of the current transformers are not used, the short-circuit jumper must not be removed.

4.4. EQUIPOTENTIAL BONDING

For connection of equipotential bonding to the substation grounding system 4 grounding points on the chassis according to DIN48088-B-M12 are designed.

4.5. POWER CONNECTION AND CONNECTION OF SIGNALLING CIRCUITS

The supply system (e.g. 3x400V/230V 50Hz) and wires of signal circuits are connected to the terminal block inside the motor drive cabinet according to the wiring diagram. This wiring diagram is part of Trading and technical product documentation.

4.6. TIGHTENING TORQUES

When connecting cables to bushings, observe the following tightening torques:

Bolt thread	Tightening torque (Nm)
M12	10
M20	30
M30	100

5. COMMISSIONING

Commissioning means the sum of operations and checks that must be performed before connecting the equipment to the network. The basis for commissioning is the supplied routine test report, included in the delivered Trading and technical documentation.

The arc suppression coil is produced and tested in accordance with the IEC 60076-6 standard.

5.1. EXAMINATION OF MECHANICAL PARTS

Examination of mechanical parts means:

- Verification whether the closing flaps of radiator flanges, valves between the coils cover and expansion tank etc. are open - if not, these must be opened,
- Check of tightness of all flanges of the Buchholz relay, radiators, conservator, oil valves, tank, possibly of the 110kV bushing,
- Check of bolted joints of conservator brackets, radiators, flanges etc.

5.2. EXAMINATION OF ELECTRICAL PARTS

- Check of bushing connections, including their mechanical and electrical completion,
- Check of connections inside the terminal cabinet according to the wiring diagram
- Check of the motor running and functions of limit switches



The condition of faultless function is observance of the clockwise phase sequence on the terminal board of the motor drive cabinet

- Check of the manual operation from the motor drive control cabinet,
- Verification of the automatic control using automatic controller or substation control system (if applicable)
- Check of electrical connections and resistor switching using automatic controller or substation control system (if applicable)
- Measurement of insulation resistances (acc. to IEC 60076-3:2013 chapter 9)



before testing of insulation of auxiliary circuits it is essential to disconnect the devices with lower test voltage (thermometers, Pt100, oil level indicator etc. – please see the data sheets), it is also essential to disconnect all the semiconductor and microprocessor devices (e.g. current injection unit CIF etc.)

5.3. VERIFICATION OF INSTRUMENTS FUNCTIONALITY

- Check of functionality of instruments and devices used (see *Operating Instructions 4*)
- Control of settings and signalling fault conditions,
- Check of the connection between the equipment and automatic controller, or the automatic substation control system



Before venting, the arresting rubber inserts from the test button of the Buchholz relay must be removed.

5.4. VERIFICATION OF THE OIL CONDITION

- Check of quality of the used oil [1)],
- Carry out venting according to *Operating instructions 5,*
- Checking air dryer, the procedure depends on the specific type of used dryer (see Operating instructions of the dryer),
- Check of the oil level in the conservator, which must correspond to the appropriate level for the ambient temperature (correction of oil level is performed according to Operating instructions 1).
- In case a valve is mounted on the connecting pipe, which ensures the flow of oil between the tank and conservator, the valve must be in open (operating) position !

The arc-suppression coil must not be operated with closed valve!!!

[1)] Description of technical parameters of the oil is part of the Trading and technical documentation. The method of sampling oil and the scope of tests are given in the *Operating instructions 1*.

6. CURRENT SETTING

The coil is tunable from I_{min} to I_{max} and in the same time from I_{max} to I_{min}. The time of crossing from I_{min} to I_{max} is always stated in the routine test report.

6.1. MANUAL SETTING

The arc-suppression coil is set to minimum current value and connected to the network without earth fault. With gradually increasing current setting of the arc-suppression coil, the corresponding voltage of the measuring winding is measured.

The so measured resonance curve has a maximum value of the measured voltage at such current value of the coil, which corresponds to the capacitive current of the

network. At this current the inductance of the coil is tuned into resonance with the earth capacities of the network.

But because of their possible imbalances, some substantial differences of the network phase voltages may arise. This difference is minimized by partial arc-suppression coil detuning.

6.2. SETTING BY AUTOMATIC CONTROLLER

Within manual mode of the automatic controller the arc-suppression coil is first mistuned from its tuned condition. It means to set a current value which is different from the value of the earth capacitance current of the network. Next procedure corresponds to applicable manual of the used controller.

7. MAINTENANCE, REVISION AND DISPOSAL

The operated equipment is not difficult to maintain, control and test. In principle only a short visual inspection and simple field tests are sufficient, that may be combined, if possible, with regular checks of upstream transformers.

7.1. VISUAL CHECK

The manufacturer recommends do these tests at least 1x every 6 months. They are to be performed during operation from a safe place and in compliance with all safety regulations. It consists of the following:

- Overall visual inspection. It means to check all visible sealing points. Any leaks found should be removed according to procedure given in *Operating instructions 6*
- Verification of the oil level in the conservator. The oil level in the conservator must correspond to the appropriate level of the ambient temperature. If it is necessary to correct the level, proceed in accordance with *Operating instructions 1*
- Checking the dryer condition - the procedure depends on the type of used dryer (see *Operating instructions of the dryer*)

7.2. FIELD TESTS

The manufacturer recommends to carry out these tests at least once every 2 years (excluding check of the insulation oil – see *Operating Instructions 1*). Before starting work you must meet the relevant safety regulations for working on electrical equipment.

Field tests mean:

- Inspection of sealing points on the coil as in paragraph 7.1

- Inspection of the surface protection (paint). The surface of the equipment is cleared of any dirt and the state of anticorrosive protection is verified. In case of damage, this should be corrected according to the following procedure:

a) Damaged areas, where the corrective coating will be made, are abraded with a sandpaper. The abraded paint rests are removed using compressed air.

b) The cleaned surface is degreased with benzine or other degreaser. To ensure good adhesion, the surface before application of paints must be perfectly degreased.

c) On so prepared surface apply a mixture of top coat (included in supplied package) and hardener (included in supplied package) in the proportion 10(paint) / 1(hardener) parts by weight (this proportion must be kept !). The thickness of so applied dry layer must reach a minimum of 50 to 60 µm. At 20°C the top coat is dry after 2-3 hours, and then the next paint can be applied. This time depends on the temperature of the ambient air. At lower temperature, the drying time may be extended even several times. When the ambient air temperature is below 5°C it is not possible to carry out this coating.

d) After sufficient drying of the first coat is it possible to apply the second coat. For this, use an identical coating mix as the first coating. The thickness of the second layer after drying should be at least 50-60µm.

e) The total coating layer after drying must have a thickness of 100-120µm.

- Inspection of bushings. Remove dirt from porcelain bodies. Damaged insulator bodies (hairline cracks, surface damage) must be replaced immediately. Contact surfaces are to be cleaned from corrosion and lubricated with contact vaseline. Then the screw connections must be tightened.
- Inspection of grounding points. Contact surfaces are to be cleaned from corrosion and lubricated with contact vaseline. Then tighten the screw connections.
- Measurement of insulation resistances (acc. to IEC 60076-3:2013 chapter 9)



before testing of insulation of auxiliary circuits it is essential to disconnect the devices with lower test voltage (thermometers, Pt100, oil level indicator etc. – please see the data sheets), it is also essential to disconnect all the semiconductor and microprocessor devices (e.g. current injection unit CIF etc.)

- Checking the oil. The method of oil sampling and scope of tests is mentioned in the *Operating instructions 1*.
- Inspection of the motor drive. Carry out a functional test. The maintenance is carried out in accordance with instructions for the used type of motor drive.

- Inspection of monitoring devices. Clean the glass tube of the oil level gauge, covers of instruments and their scales. Examine the right contact switching of all devices. Description of signals is mentioned in *Operating instructions 4*.

  In case of gas accumulation in the chamber of Buchholz relay it is suitable to analyse a gas sample to determine the cause of its occurrence. Carry out a functional test of the Buchholz relay according to Instruction manual, which is part of the Trading and technical documentation of the product.
- Inspection of dryer – see paragraph 7.1.
- Inspection of radiators. Examine the leaks of radiators and closing flanges. Any leaks are to be immediately removed as described in *Operating instructions 6*.

7.3. REVISION

It shall be performed at the manufacturing plant on the basis of customers demand. Based on the results of field tests, revisions in the manufacturing factory min. 1x in 15 years are recommended.

7.4. DISPOSAL

After the life of the product it is necessary to ensure its dismantling, sorting and disposal of materials through a professional liquidation firm, according to the current catalog of waste, which is based on the Law on waste disposal in force in a particular country.

The product can be classified according to the proportion of weight into the following groups:

Material Group	**Weight share in %** *) average value
Copper	9
Iron parts	61
Other	<4
Insulating oil	26

The arc supression coil consists mainly of following materials:

Tank, cover, cooling system (radiators)

clasification:	metal
chemical composition:	Fe36
physical composition:	solid
dangerous decomposition:	none
dangerous reactions:	none
clasification:	scrap metal

Magnetic circuit

clasification:	metal
chemical composition:	Fe36 – Si4
physical composition:	solid
dangerous decomposition:	none
dangerous reactions:	none
clasification:	scrap metal

Winding – metal components

clasification:	metal
chemical composition:	Cu 99,9-Fe0,05-Si0,05
physical composition:	solid
dangerous decomposition:	none
dangerous reactions:	none
clasification:	scrap metal

Winding – insulation material

clasification:	insulation
chemical composition:	cellulose paper
physical composition:	solid
dangerous decomposition:	none
dangerous reactions:	none
clasification:	industrial waste

Insulation oil

clasification:	mineral oil
chemical composition:	naphthenic or paraffinic oil
physical composition:	liquid
dangerous decomposition:	none
dangerous reactions:	none
clasification:	dangerous waste (disposal according to national regulations)

1. GENERAL

As of the date of expedition, electric machines manufactured by EGE are fully filled with insulating oil with the exception of devices that must be transported partially dismantled because of their dimensions.

- As a standard, Shell, Nynas and Lukoil insulating oils are used to fill these machines.
- Technical parameters of the actually used insulating oil are always listed in the v Technical Documentation.

Generally, it is allowed to use only such insulating oils that comply with the following regulations, as well as with the applicable national standards:

- VDE 0370
- EN 60296
- Insulating oil needed for refilling of the partially dismantled products is delivered in barrels (transported in crates). During storage, regulations related to protection of the environment must be followed.

2. FILLING AND OIL LEVEL ADJUSTMENT

For electrical machines manufactured in EGE, two basic types of tanks are used:

- ***Tank with conservator or air cushion***
- ***Hermetically sealed tank***

- To refill the machine with oil, an adequately sized oil pump is needed (min. 45l / min, 5m delivery).
- Connecting equipment is to be selected so as to match the specific oil fittings used on the given machine (see Technical Documentation for the machine).
- In case of necessary oil handling, solely clean and dry containers/tanks not containing any PCB compounds must always be used for discharged oil storage.
- The equipment may be filled from tanks only in case that the oil test results comply with the applicable regulations.

2.1 Tank with conservator or air cushion

2.1.1 Oil level lowering

- Oil level lowering is performed during service works.
- Oil is drained via bottom drain valve (gate valve).
- Before starting oil draining, the filling neck on the conservator must be opened. For the air cushion variant of the equipment, the dryer must be dismounted during filling.

2.1.2 Oil filling

- Oil is refilled via bottom oil valve, or via bottom oil sampling valve DN15, as appropriate.
- Should oil be refilled with the air dryer installed, the filling neck on the conservator must be opened.
- For the air cushion variant of the equipment, filling is generally performed with the dryer dismounted.
- If the machine is fitted with radiators, all shut-off flaps for radiator connection must be opened.
- Oil is to be filled up to the level corresponding to the ambient temperature (see the oil sight glass scale).
- After completion of filling, radiators gas relay, and bushings are vented (see *Operating Instruction 5*)
- Before connecting to the network, the machine must be left 24 hours at rest (oil level stabilisation). After this time, the control of venting, the oil level check, and the visual inspection of all flanges and sealing surfaces for oil leaks must be done again.

Special machine version with conservator equipped with bag separating oil from the air

- Oil is refilled via bottom oil valve, or via bottom oil sampling valve DN15, as appropriate.
- The dryer is dismounted. For tanks with radiators, all shut-off flaps must be opened.
- The bag is pressurised through the tube to the dryer to 10 kPa.
- Venting valves on both conservator front sides are opened.
- During oil filling, the pressure in the bag must not exceed 13 kPa.
- Filling is stopped as soon as the oil begins flowing out from venting valves on the front sides of the conservator. At this moment, the valves will close.
- Overpressure from the dryer tube is discharged and the pressure gauge removed.
- Oil filling continues until the oil sight glass will show the correct level, depending on the machine temperature (see the oil sight glass scale).
- The air dryer is mounted on (see the Dryer Operating Instructions).
- Subsequent procedure – measures as venting, oil level stabilisation, etc. – is the same as for the standard version.

2.1.3 Oil level adjustment

To each machine temperature, certain oil level can be assigned. For important temperatures, the oil levels are marked on the oil sight glass.

If adjustment of the oil level is needed, it is carried out via used oil fittings.



The oil sight glass is not intended for temperature reading.

2.2 Hermetically sealed tank



Hermetically sealed machines are already factory ready for operation. Any manipulation with venting valves, or even opening of the filling tube, will cause impairment of hermetic condition and thus necessity to perform hermetic re-sealing according to point 2.2.4.

2.2.1 Oil level lowering

Should maintenance and/or repair require opening of a hermetically sealed machine, proceed as follows:

- Oil is drained via bottom drain valve (gate valve).
- **CAUTION:** Before starting oil draining, the filling tube on the machine cover must be opened.

2.2.2 Oil filling

After service work completion, the machine must be refilled with oil and hermetically sealed according to the following procedure:

- Oil is refilled via bottom oil valve located on the machine container.
- Before filling, it is recommended to put e.g. a wooden prism under the machine on the filling tube side. This reduces the risk of air bubbles in the filled machine.
- Unscrew the cap or the pressure relief valve (as appropriate) on the filling tube.
- Then fill the machine completely with oil so that also the filling tube is full.
- After completion of filling, hermetic re-sealing according to point 2.2.4 must be performed.
- Maintenance instructions for installed protection and monitoring equipment must be observed.
- Before connecting to the network, the machine must be left 24 hours at rest. After this time, the oil level check and the visual inspection of all flanges and sealing surfaces for oil leaks must be done again.

2.2.3 Oil level adjustment

If an oil level adjustment is needed, it can be performed in two different ways depending on the machine condition. An estimate of the machine condition can be performed by checking the oil sight glass:

1) Oil is visible in the oil sight glass

   This is a case when oil is visible in the sight glass, but below the maximum value. In this case, the amount of oil is sufficient for machine operation. It is recommended to use a vacuum pump and to pump excessive air out from the machine. This must be performed according to the manual for the combined instrument in question.

2) Oil is not visible in the oil sight glass

   In this case, it is necessary to check the sealing points and the seals on the filling and draining valves of the machine. If the seals are not damaged and there is no visible leakage in the sealing points, sufficient amount of oil in the machine for proper operation can be expected. In this case, you may try to pump excessive air out from the machine using a vacuum pump. This must be performed according to the manual for the combined instrument in question. If air cannot be pumped out from the machine using a vacuum pump, the machine must be refilled with oil according to point 2.2.2.

CAUTION - When opening the filling tube, oil temperature in the machine must be taken into account. If the oil temperature is bellow 40°C, there is underpressure in the container and opening a valve will cause air suction. Thus, more oil will have to be filled into the machine. Therefore, if practicable, it is appropriate to perform this work at oil temperatures as close to 40°C as possible.

2.2.4 Hermetic sealing of the machine

In the manufacturing factory, the machine is filled with oil and hermetically sealed. It is assumed that this condition should last throughout the machine life. In rare cases such as, e.g., repair, the hermetic condition of the machine must be impaired. However, after completion of such works on the machine, the machine has to be returned to hermetic condition - hermetically sealed.

In case of any intervention in the machine, it must be taken into account that, in the manufacturer's factory, the machine is filled with oil at temperature of 40°C. The oil volume, specified at the machine nameplate, and also balanced pressure in the container correspond to that temperature. It also follows from the above that if the machine is filled with oil at other temperature than 40°C, the oil volume needed will be different from the rating plate value. This will also cause that the machine will not work within the prescribed pressure range. It is therefore ideal to perform all works on the machine at oil temperatures as close to 40°C as possible.

CAUTION - Hermetic sealing of the machine at oil temperatures over 40°C is not feasible.

Machine conditions at temperatures different from 40°C:

a) Oil temperature is lower than 40°C

At temperatures lower than 40°C, a hermetically sealed machine works in underpressure. This means that opening of the filling tube neck or any venting valve will cause air suction into the machine. When filling such machine, higher volume of oil will also be needed than the prescribed machine rating plate volume.

b) Oil temperature is higher than 40°C

At temperatures higher than 40°C, the machine works in overpressure. Opening the filling neck or venting valves will cause oil delivery out from the container.

Procedure of hermetic sealing:

1) Fill the machine, including the filling tube, up to the edge.
2) Vent the bushings and instruments according to *Operating Instruction 5* (only bushings with venting elements, combined instrument).
3) If necessary, oil must be refilled into the filling tube in the course of venting.
4) Close the venting valves.
5) Close the filling tube by overpressure valve and seals.
6) Discharge the prescribed volume of oil via the bottom drain valve of the tank. During discharge, air must be prevented from entering the tank. The oil volume needed is calculated according to the following formula:

$$V = G * k * (40 - T) \quad [\mathrm{dm}^3]$$

V ... volume of discharged oil [dm³]

k = 0.0007696 [dm³ kg⁻¹ °C⁻¹] - coefficient including weight conversion to oil volume and thermal expansion

G ... weight specified in the nameplate [kg]

T ... oil temperature in the machine [°C]

7) After oil discharge, close the bottom drain valve.
8) If the machine is equipped with a combined instrument, check the oil level in the oil sight glass.

To prevent possible leaks, we recommend fitting all dismounted parts with new seals.

3. MONITORING OIL QUALITY

Oil condition should be evaluated through periodic checks. The scope and method of test performance are governed by regulations in force, such as EN 60296 (IEC 60296:2012), VDE 0370 (Part 1, Part 2), and further by relevant national standards.

3.1. Oil sampling

Sampling and sample handling must follow regulations actually in force, in particular IEC 475 (DIN EN 60475).

- Before sampling, the place of sampling, as well as auxiliary means must be cleaned and dried.
- Care should be taken that the oil sample does not absorb moisture.
- In order to prevent humidity condensation in the small oil cup with oil sample at low temperatures, the temperature of oil and the oil cup must be equal.
- Before sampling, about 3 l of oil has to be discharged in a separate tank.
- Oil samples should have a volume of about 2 l.
- Before the oil test is performed, the oil sample should be stored at room temperature (no more than 5 days)

3.2. Sampling oil from hermetically sealed tanks

In hermetically sealed tanks, the insulating oil is not in contact with the environment. For this reason, oil degradation will not be as fast as with other types of machines. Therefore, we recommend performing sampling only in case of failure or non-standard operational behaviour of the machine.

Sampling is performed as follows:

1) Sampling of oil when the oil temperature is > 40°C. At this temperature, the tank is working in overpressure. Sampling is carried out through the drain valve. In this case, opening the filling tube during sampling is not appropriate. When opening it, there is a danger of oil leakage to the machine cover due to overpressure.
2) Sampling of oil when the oil temperature is < 40°C. At this temperature, the tank is working in underpressure. Sampling is carried out through the drain valve. To ensure sufficient volume of oil taken, it is in this case recommended to open the filling tube during sampling.



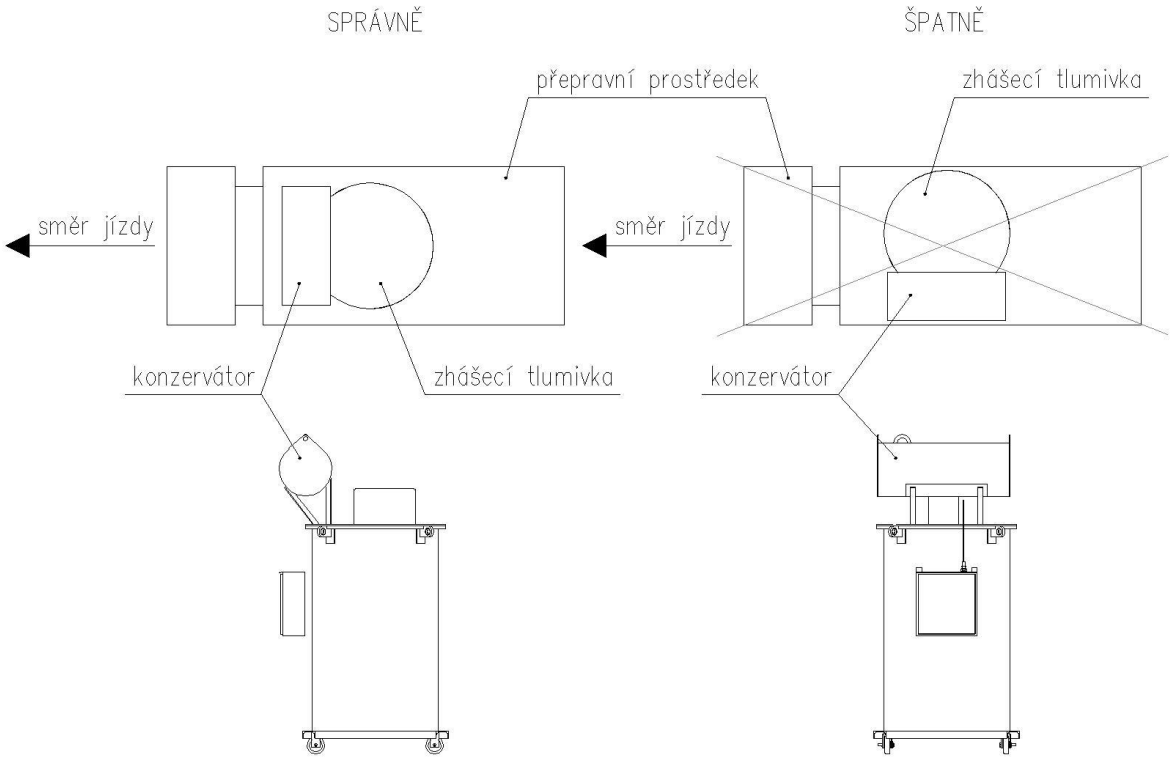
After sampling, hermetic sealing according to point 2.2.4 must be performed! If the oil temperature is higher than 40°C, waiting till it cools bellow that limit is necessary, see 2.2.4.

In the event that the product is made with a conservator, it must be placed on the loading area of the transport vehicle so that the conservator is situated transversely to driving direction (see Fig.1).

It has to be attached on 4 lifting eyes (or hooks) placed below the cover on the tank.

Fig.1. Position of the equipment on the vehicle loading area.

SPRÁVNĚ= correctly přepravní prostředek=transport vehicle ŠPATNĚ= incorrectly



směr jízdy =driving direction zhášecí tlumivka=arc-suppression coil konzervátor=conservator

The choice of transport vehicle, the list of transport units, the method of loading and handling of transport units shall be regulated by Article 1 of General operating instructions.

The equipment is transported with removed chassis wheels. The wheels are (including all accessory parts) placed in a transportation crate, or mounted on the top side of the chassis.

In order to enable assembly of chassis wheels in the substation, the equipment must be properly lifted (see Table 2, Article 1.3 of the General operating instructions).

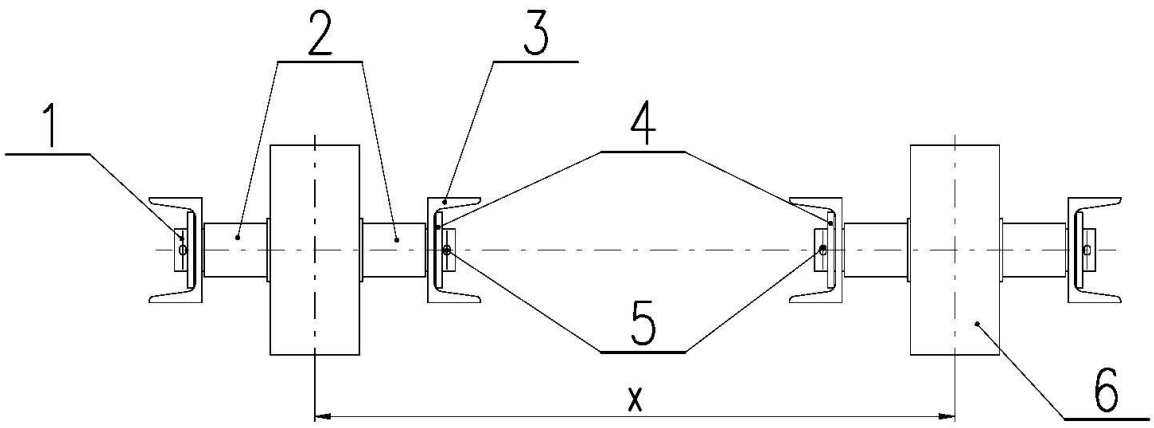
Description of assembly of different types of wheels follows:

1. PLAIN WHEELS (frame chassis design)

Figure 1 shows the proper assembly procedure.

The wheel shaft (pin) has to be put from one side into the drilled hole in the chassis frame and successively a distance ring, a wheel and a second distance ring are put on. The shaft (pin) is secured in the frame on both sides by a washer with cotter pin. The wheel is arrested by tightening the screw radially to the wheel.

Fig.1. Assembly of plain wheels on the frame.



Legend:

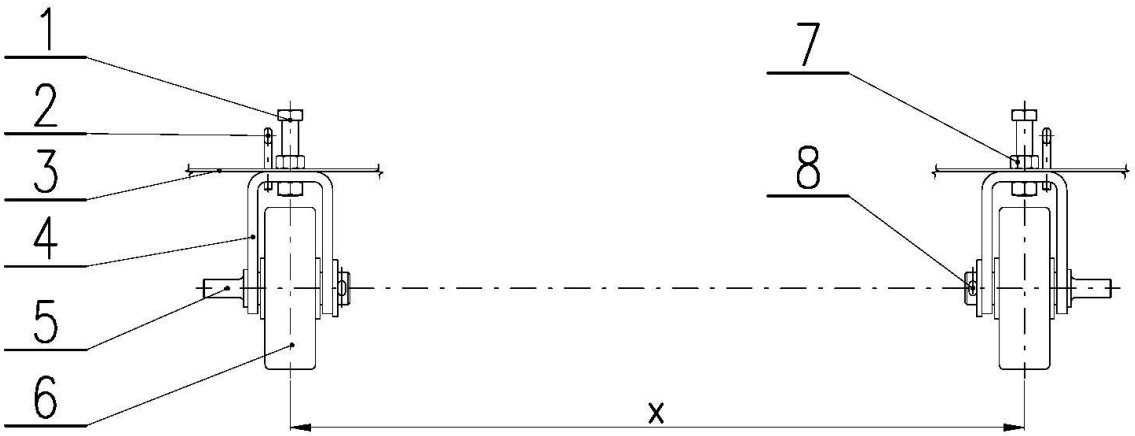
1. shaft (pin)
2. distance ring
3. frame
4. washer
5. cotter pin
6. wheel

2. PLAIN WHEELS (Yoke chassis design)

Figure 2 shows the proper assembly procedure.

This type of wheels is already factory assembled for installation (including the yoke and shaft). The assembly has to be bolted to the chassis frame with one screw, secured by a locknut and after wheel alignment secured with a cotter pin. The wheel arrestment is carried out by tightening the screw (position 1) radially to the wheel and its securing with nut (position 7).

Fig.2. Assembly of plain wheels in the yoke.



Legend:

1. bolt
2. cotter pin
3. frame
4. wheel yoke
5. shaft
6. wheel
7. locknut
8. cotter pin

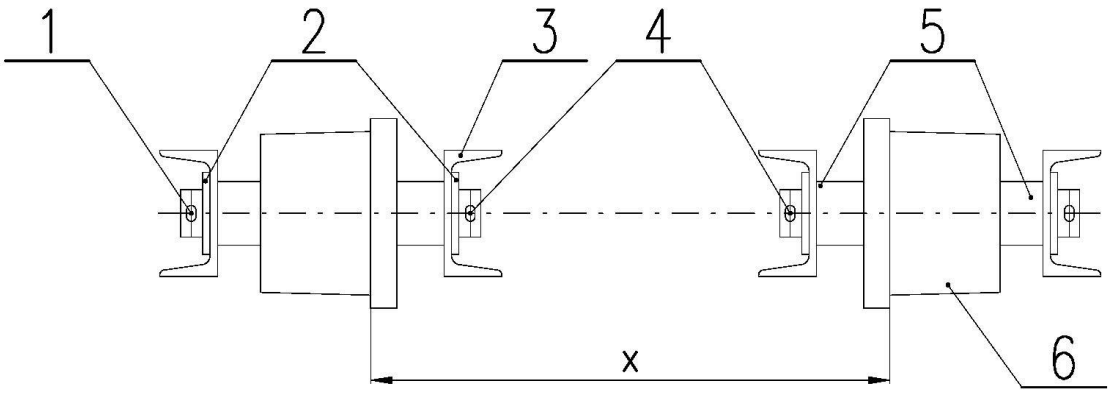
3. FLANGED WHEELS *(frame chassis design)*

Figure 3 shows the proper assembly procedure.

The wheel shaft (pin) has to be put from one side into the hole in the chassis frame and successively a distance ring, a wheel and a second distance ring are put on. The shaft (pin) is secured in the frame on both sides by a washer with cotter pin. The wheel arrestment is carried out by tightening the screw radially to the wheel.

During assembly, the axis spacing and alignment of wheels must be checked (see Technical product documentation).

Fig.3. Assembly of flanged wheels in the frame.



Legend:

1. pin
2. washer
3. frame
4. cotter pin
5. distance ring
6. wheel

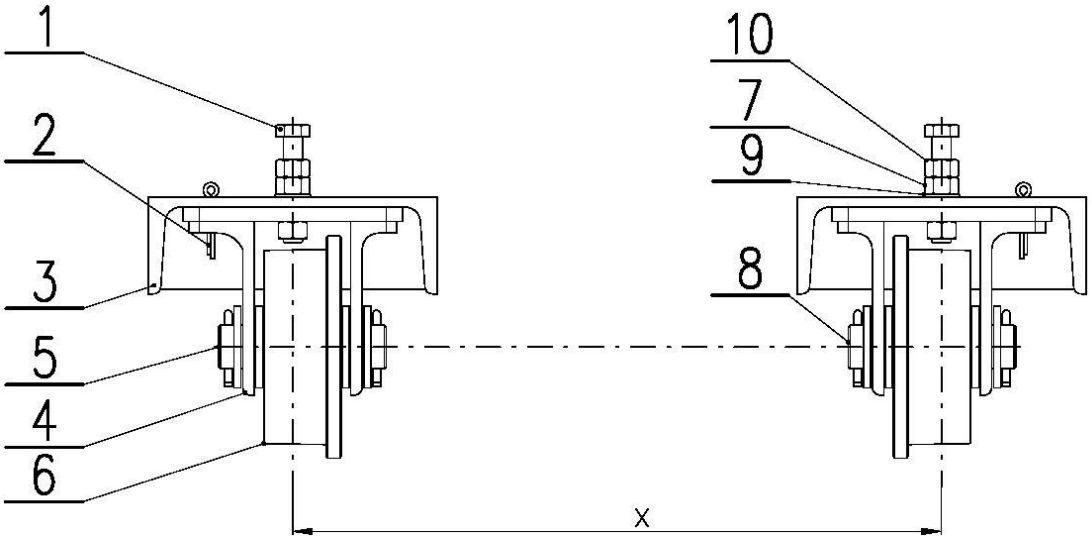
4. FLANGED WHEELS (yoke design)

Figure 4 shows the proper assembly procedure.

This type of wheels is already factory assembled for installation. The assembly has to be bolted to the chassis frame with one screw (pos. 1), secured by a locknut (pos. 10) and after wheel alignment secured with a cotter pin pos. 2). The wheel arrestment is carried out by tightening the screw (pos. 1) radially to the wheel.

During assembly, the axis spacing and alignment of wheels must be checked (see Technical product documentation).

Fig.4. Assembly of flanged wheels in the yoke.



Legend:

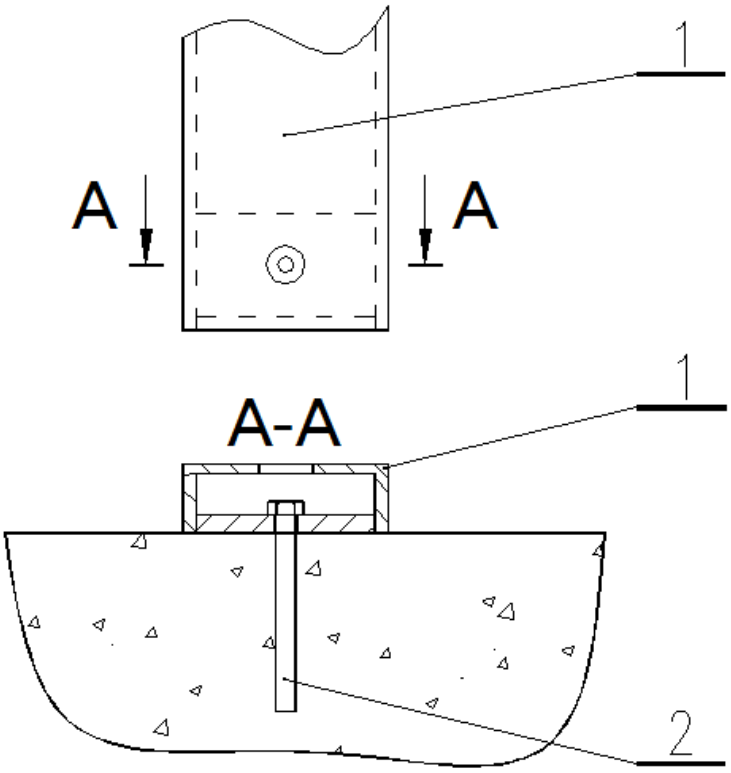
1. bolt
2. cotter pin
3. frame
4. wheel yoke
5. shaft
6. wheel
7. nut
8. cotter pin
9. washer
10. locknut

5. DESIGN FOR INCREASED SEISMIC RESISTANCE (chassis without wheels)

Figure 5 shows the proper assembly procedure.

The equipment is positioned on a concrete base. Then it is fixed by anchors directly to the concrete base. The specific dimensions of anchors are given in the Technical product documentation.

Fig.5. Fixing to the concrete base



Legend:

1. frame
2. anchor

The machine is equipped with control devices according to customer requirements (see Trading and Technical documentation). One part of trading documentation sent to the customer consists also of instruction manuals for each device, installed on the machine. The final user of the machine is obliged to read these manuals and follow them when operating such devices.

The following tables provide an overview of signals for each device.

1. OIL LEVEL GAUGE (magnetic oil level gauge with contacts)

Device signal	Cause	Removing the cause, notes
„minimum“	Exceptionally low temperature (due to strong cooling)	
	Machine has a leak	• Identify and remove the cause of the leak • Add the oil
„maximum“	The oil level has reached a level that corresponds to the maximum oil temperature	
	Excessive amount of oil	• Drain the oil

2. OIL LEVEL DETECTOR

Device signal	Cause	Removing the cause, notes
„warning“	Exceptionally low temperature (due to strong cooling)	
	Machine has a leak	• Identify and remove the cause of the leak • Add the oil

3. THERMOMETER WITH CONTACTS

Device signal	Cause	Removing the cause, notes
„warning“	The oil temperature in the machine approaches the maximum permissible oil temperature. If the customer does not require different value setting, the switching temperature is set 10 ° C below the permitted oil temperature. <u>Factory settings:</u> **Arc-suppression coils** and **combined** arc-suppression coils: - long-term operation, combination of long-term and other operation - 100 °C - short-term operation, maximum running time 2h - 110 ° C **Earthing transformers** and **shunt reactors** - for all operation modes 90°C	• Watch the temperature increase • prevent exceeding the permitted oil temperature.
„disconnection“	The oil temperature in the machine has reached the maximum permissible oil temperature. If the customer does not require lower value setting, the temperature is set to the maximum possible oil temperature for the given machine. This value must not be exceeded. <u>Maximum values (factory settings):</u> **Arc-suppression coils** and **combined** arc-suppression coils: - long-term operation, combination of long-term and other operation - 110 °C - short-term operation, maximum running time 2h - 120 ° C **Earthing transformers** and **shunt reactors** - for all operation modes 100°C	• **The machine is not allowed to operate.** • Exceeded permitted oil temperature can damage the machine.

4. THERMOSTAT

Device signal	Cause	Removing the cause, notes
„warning“	The oil temperature in the machine approaches the maximum permissible oil temperature. If the customer does not require different value setting, the switching temperature is set 10 ° C below the permitted oil temperature. <u>Factory settings:</u> **Arc-suppression coils** and **combined** arc-suppression coils: - long-term operation, combination of long-term and other operation - 100 °C - short-term operation, maximum running time 2h - 110 ° C **Earthing transformers** and **shunt reactors** - for all operation modes 90°C	• Prevent exceeding the permitted oil temperature.

5. BUCHHOLZ RELAY

Device signal	Cause	Removing the cause, notes
„warning“	Accumulation of air or gas in the chamber:	
	a) low oil level in the machine – cause: exceptionally low ambient temperature or leakage	• Remove possible leakage • Add the oil
	b) relay not vented	• Vent the relay
	c) release of gas	• Consult next steps with manufacturer
	It is not necessary to take the equipment out of service, but the cause of this signal must be found and removed without delay.	
„disconnection“	Pressure wave.	
	Emergence of serious damage the cause of which may be: a) damaged insulator, b) inception of electric arc, c) winding short-circuit, d) low oil level	• **The machine is not allowed to operate,** **Immediately contact the manufacturer!**

6. SERVICE-FREE DRYER MESSKO MTraB

Device signal	Cause	Removing the cause, notes
„failure“	Internal device fault.	• Check the correct connection of the device according to the attached data sheet and Technical and Trading documentation.

7. COMBINED DEVICE

Device signal	Cause	Removing the cause, notes
TEMPERATURE „warning“	The oil temperature in the machine approaches the maximum permitted temperature. Factory settings: - standard switching temperature is 90 °C	• Watch the temperature rise, prevent exceeding the permitted oil temperature.
TEMPERATURE “disconnection”	The oil temperature in the machine has reached the maximum permitted temperature. Factory settings: - standard switching temperature is 100 °C	• **The machine is not allowed to operate.** **Exceeded permitted oil temperature can damage the machine**
PRESSURE “maximum”	The pressure inside the tank is approaching the permitted maximum pressure. Factory settings: - standard pressure is 30 kPA	• Prevent exceeding the permitted maximum pressure
OIL LEVEL “minimum”	Excessive gas evolution or a significant change in the oil level.	• Check sealing points against possible leakage. Discharge the accumulated gas through the vent valve and add oil in accordance with the "Operating instructions 1 - insulating oils". • In case of repeated signalling contact the manufacturer.

On the new or revised equipment venting should be carried out. Depending on the design and type of equipment, venting of following parts is to be successively performed:

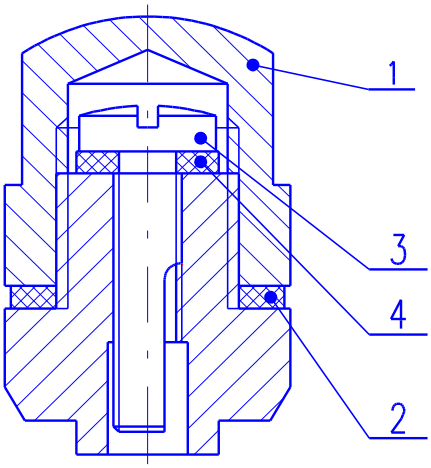
- radiators,
- medium, HV and VHV bushings (possibly mounting flange of bushings),
- Buchholz relay

Bushings corresponding to standard DIN 42530, EN 50386 (1kV) as well as bushings according to standard DIN 42539 (3kV) need no venting.

1. RADIATOR VENTING

Only radiators according to standard DIN 42559 have to be vented. Each radiator has in its upper part a venting screw (size 6 according to standard DIN 42558) – see Fig.1.

Fig.1. Radiator venting valve



1 – Cover nut
2 – Gasket of the cover nut
3 – Venting screw
4 – Gasket of the venting screw

Venting procedure:

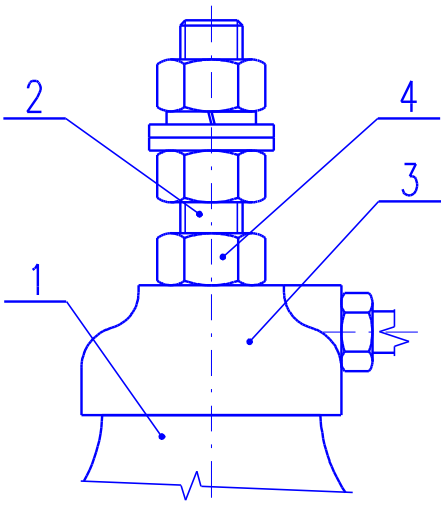
Unscrew the cover nut (1) and loosen the venting screw (3). If only oil without air bubbles starts to flow out, retighten the screw. Screw back into position the cover nut and clean the radiator from oil rests.

2. BUSHINGS

2.1. High voltage bushings according to standard DIN 42531, EN 50180 (10, 20, 30kV - 250A)

These bushings do not have venting screws – see Fig.2.

Fig.2. Bushing DIN 42531, EN 50180



1 - Porcelain body of the bushing
2 - Bushing bolt
3 - Cap
4 - Nut M12

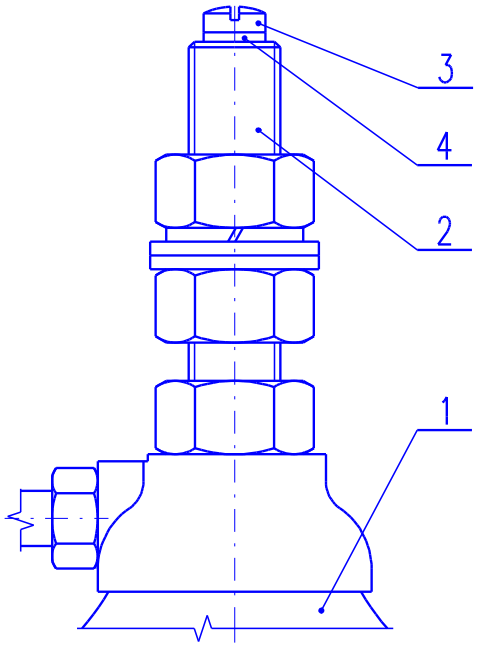
Venting procedure:

Wrap a cloth around the porcelain body (1) of the bushing. Loosen nut M12 (4) on the connecting bolt (2), compressing the bushing. Remove cap (3) with gasket. If only oil without air bubbles starts to flow out, retighten the nut (4). Clean the porcelain body perfectly from oil rests.

2.2. High voltage bushings according to standard DIN 42532, EN 50180 (10, 20, 30kV - 630A).

These bushings have on the end of the connecting bolt (M20) a venting screw M8 with gasket – see Fig. 3.

Fig.3. Bushing DIN 42532, EN 50180



1 - Porcelain body of the bushing
2 - Bushing bolt
3 - Venting screw
4 - Gasket

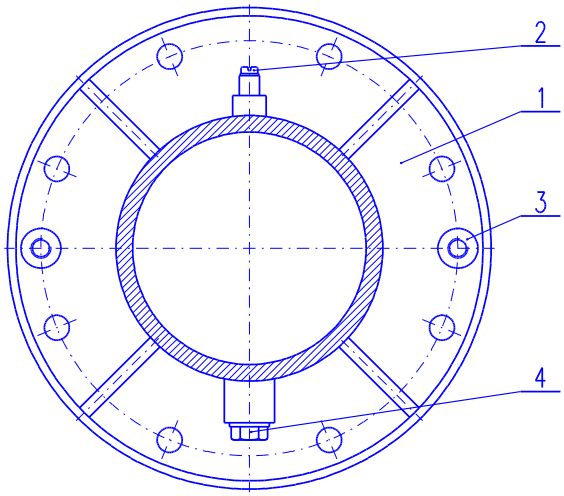
Venting procedure:

Wrap a cloth around the porcelain body (1) of the bushing and loosen the venting screw (3). If only oil without air bubbles is flowing out, retighten the screw. Remove perfectly all oil rests from the porcelain body.

2.3. Very high voltage bushings (capacitor bushings) for arc-suppression coils for 110kV networks.

Usually the venting screw is situated in the lower part on the mounting flange of the bushing – see Fig.4.

Fig.4. 110 kV bushing flange



Drawing without scaling

1 – Bushing flange
2 – Venting screw
3 – Earth terminal
4 – Test terminal

Venting procedure:

Wrap a cloth around the lower mounting flange on the cover (1) and loosen the venting screw (2). If only oil without air bubbles is flowing out, retighten the screw. Remove perfectly all oil rests from the porcelain body.

2.4. Flange of vn and vvn (HV and VHV) bushing

On some equipment the bushing is placed in a mounting flange. The venting screw as part of the bushing flange is situated in its top. Before putting the coil into operation, this flange must be vented.

Venting procedure:

Wrap a cloth around the flange (screw) and loosen the venting screw. If only oil without air bubbles is flowing out, retighten the screw. Remove perfectly all oil rests from the mounting flange.

3. BUCHHOLZ RELAY VENTING

The venting procedure is described in detail in Operating Instructions for Buchholz relay, which is part of the Trading and technical product documentation.

Causes of leakage can be different, e.g. loose screws, damaged seals or damaged porcelain body of bushings.

In case of possible leaks of welds on the tank, the manufacturer should be informed immediately.

Occurring leaks should be promptly eliminated to prevent further damage of the machine. Work on the equipment should in principle be performed by trained personnel in compliance with work safety. The unit must be disconnected from the mains.

1. Tightening of screw joints

- Tighten the screw connection in place of leakage, such as valves.
- If the leakage continues, the gasket must be replaced

2. Replacing damaged gasket

- Reduction of oil level according to Operating instructions 1, Article 4.3,
- Disassembly of relevant parts,
- Exchange of gaskets including cleaning of sealing surfaces (from oil),
- Assembly of parts and adding oil in accordance with the Operating instructions 1 article 4.1,
- Venting according to Operating instructions 5.

3. Replacing damaged porcelain body of bushings

- Disconnect the electrical supply,
- Reduce oil level according to Operating instructions 1, Article 4.3,
- Loosen screw joints securing the bushing, loosen nuts and cap on the bolt and remove the porcelain body,
- Clean the sealing surfaces between the bushing and the cover (oil removal) and put a new gasket,
- Install a new porcelain gasket,
- Add oil according to Operating instructions 1 Article 4.1,
- Connect the power,
- Vent according to Operating instructions 5.

As a standard the electrical equipment is designed for environment classified according to standard EN ISO 9223 with C4 degree of corrosive aggressiveness of the atmosphere. For extreme conditions the equipment is designed with C5 degree of corrosive aggressiveness of the atmosphere.

The corrosion resistance of the materials used and the surface protection correspond to these environments.

1. TRANSPORT

The manufacturer defines the environmental conditions for transport by a set of classes IE23 combinations according to standard IEC 60721-3-2. No additional anti-corrosion measures are required for these transport conditions.

For transport in Europe during winter period the manufacturer recommends to cover the product with a tarpaulin. If during this period the transported product is uncovered for more than 3 hours, the manufacturer recommends after assembly of the product to rinse the outer surface with water to remove de-icing salt deposits.

2. STORAGE

Unless otherwise agreed the storage conditions are specified by the manufacturer with a set of classes 1K8 / 1Z2 / 1Z5 / 1B2 / 1C2 / 1S3 / 1M3 according to standard IEC 60721-3-1.

The manufacturer recommends temporary surface protection for long-term storage according to Table 1. The reason is the fact that metal parts without surface treatment (eg brass, stainless steel) as well as all surface coatings can be exposed to higher corrosion stress during storage compared to normal operating conditions.

Table 1. Recommended temporary surface protection for long-term storage

Degree of corrosive aggressiveness of the atmosphere	Storage period [months]	Surfaces with coating system	Metal surfaces (metal , metal coating)
C4	< 3	-	-
	≥ 3	-	-
	≥ 6	packaging	packaging / conservation
C5	< 3	-	-
	≥ 3	packaging	packaging / conservation
	≥ 6	packaging with desiccant	conservation, packaging with desiccant

The recommended conservation medium is Shell Gadus S2 V100 3.

If the storage or transport time exceeds the planned period it is necessary to check the product, conditions of the packaging and desiccants. If the protective effectiveness is reduced, it is necessary to ensure its renewal (re-conservation, active desiccant, etc.).



Unless explicitly specified differently when ordering, during storage of the product without temporary surface protection, it is necessary to avoid

- external pollution of SO_2 higher than 40 $\mu g.m^{-3}$
- harmful fumes and vapors
- steam
- humidity exceeding 80% for a period longer than 5500 $h.r^{-1}$
- excessive dustiness and abrasive dust

3. STATIONARY USE

Unless otherwise agreed the conditions for stationary use are specified by the manufacturer with a set of classes 4K2 / 4Z1 / 4Z7 / 4B1 / 4C2 / 4S3 / 4M4 according to standard IEC 60721-3-4.Corrosion protection and components are selected so that no additional anti-corrosion measures are required.

Coating systems are designed in accordance with standard EN ISO 12944-5 and are suitable for the individual environments specified when ordering.



Unless explicitly specified differently when ordering, during stationary use of the product, it is necessary to avoid

- external pollution of SO_2 higher than 40 $\mu g.m^{-3}$
- harmful fumes and vapors
- steam
- humidity exceeding 80% for a period longer than 5500 $h.r^{-1}$
- excessive dustiness and abrasive dust