

# GENERAL OPERATING INSTRUCTIONS FOR ARC SUPPRESSION COILS

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## ANNEXES:

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# 1 PACKING AND TRANSPORT

## 1.1 CHOICE OF TRANSPORT MEANS

In the corresponding size drawing of the Commercial and Technical documentation of the product as well as in the entirety and quality certificate you can find the data necessary for the choice of the convenient loading and transport means. These documents include also weight and transport units data.

## 1.2 TRANSPORT UNITS

According to the type the ASCs are transported either assembled or disassembled into several transport units. The summary of transport units corresponding to individual types of ASC is specified in Table 1.

TABLE 1.

ASC Type	complete ASC	ASC with dismantled- conservator	crating with conservator	crating with oil barrels	case with bushing D1	case with accessories 1)	crating with radi- ators
ZTC 50, 250, 800, 1250	+	-	-	-	-	+	-
ASR 1.6	+	-	-	-	-	+	-
ASR 2.0	+	-	-	-	-	+	-
ASR 3.2 2)	+/-	-/+	-/+	-/+	-	+	-
ZTC 4000	-	+	+	+	-	+	+ 3)
ZTC 5000	-	+	+	+	+	+	-

Comment:

+ unit being an integral part of the delivery

- unit being not an integral part of the delivery

1) The ASC accessories cover the following items:

- traversing rollers including mounting fittings
- remote indicator and Uo indicator (if any)
- air drier including the charge (if the ASC is transported with dismantled conservator)
- packings necessary when assembling the transport units
- other alternative superstandard outfit

2) According to the type of vehicle it is possible to transport the ASC either as a complete machine or with dismantled conservator.

3) Applicable only to ASC provided with radiators (permanent service)

## 1.3 TRANSPORT AND HANDLING EQUIPMENT

For handling the ASC or its removable part we use handling equipments mentioned in Table 2.

TABLE 2.

number	part	placement	purpose
4	suspension eye	on the tank under the flange connecting the tank with the cover	for lifting complete equipment by crane and for fixing during transport
4	suspension eye	on the tank cover	lifting the removable part by crane 1)
4	traversing roller	tank undercarriage	longitudinal and cross traversing
4	draw eye	bottom part of the tank	longitudinal and cross traversing
4	lifting foot	bottom part of the tank	lifting the complete equipment by lifting jack

1) Caution ! The suspension eyes are not allowed to be used for lifting the complete ASC except the ZTC 50 type where the suspension eyes are intended for lifting the whole equipment.

The ASC handling should be carried out very carefully. The length of suspension cables should be chosen in order to avoid possible mechanical damage of ASC parts, such as bushings, coservator, radiators etc.. Maximum regard should be paid to avoid possible coating damage during the handling. Other transport units - cases and cratings - could be lifted by means of a high-lift truck or crane using cables passed under the whole transport unit. The individual parts of the packing -i.e. cases and cratings or parts of the product inside the packing are not intended for direct suspension.

#### 1.4 SECURING THE LOAD DURING TRANSPORT

During the transport the load placed on the loading area should be secured according to the Operating Instructions 2.

#### 1.5 IDENTIFICATION OF POSSIBLE TRANSPORT DAMAGES

To simplify the complaint procedure the manufacturer recommends to check immediately after the arrival of the ASC the entirety of the delivery according to the shipping list as well as to the entirety and quality certificate. You have to verify whether all transport units are really undamaged as well as to carry out a visual control of tightness of the ASC bushings, valves, filling holes and flanges. Do not forget to examine the protective coating for possible damages.

In case of an incomplete delivery or in case of any found defect we recommend to follow these instructions:

- before unloading the delivery you should take pictures which would represent a plausible document proving the defect incidence and write a record where you have to specify the defect or trouble.
- do notify the supplier immediately and wait for instructions.

## 2 STORAGE

### 2.1 STORAGE OF AN ASC DELIVERED AS FULLY ASSEMBLED MACHINE

#### 2.1.1

The ASC having been delivered as complete equipment are allowed to be stored in areas corresponding to required working conditions (stated in Article 3.1 - General Operating Instructions for ASC) for an unlimited period, provided that regular controls of the drying agent of the air drier are carried out.

According to the Operating Instruction 8 the estimation of the drying agent condition have to be made once within three month at least. During the storage it is necessary to avoid damages by dew to devices inside the motor drive operating box. This can be realized by means of convenient drying agent or through switching on the heating of the box (see the relevant wire diagram of the motor drive circuits). The undercarriage rollers are to be fitted on not before the ASC installation on site. For this reason it is recommended to support the frame of the undercarriage during storage in order to avoid any damage to the ASC coating.

#### 2.1.2

The accessories case, so far it contains also indicators (remote indicator, Uo indicator) has to be stored in an indoor room with a temperature ranging between -20°C to 50°C and relative air humidity  $\leq 80\%$  guaranting the temperature variation only in limits avoiding the occurrence of dew on devices.

### 2.2 STORAGE OF DELIVERD PARTLY DISASSEMBLED ASC

#### 2.2.1 Storage of a fully assembled ASC.

The ASC to be completed before storage will be assembled in conformity with the scope of necessary works according to the article 3.3 to 3.6 of these General Operating Instructions. If the ASC air drier is transported in the same case as the ASC accessories are, the case after its removal must be closed again (it contains also the necessary packings). The following procedure corresponds to the Article 2.1 - Storage of an ASC delivered as fully assembled machine.

#### 2.2.2 Storage of a partly disassembled ASC.

This kind of storage is not recommended by the manufacturer !

If despite this advise this kind of storage is required, the customer has to ask in his order for special ASC outfit. In such a case the ASC tank has a provisional contact part and an air drier. All trasport units beeing integral part of the delivery have to be stored in spaces and areas corresponding to the conditions mentioned in Article 2.1.2. The next step corresponds to the Article 2.1.1- Storage of delivered fully assembled ASC.

Caution ! In case of this kind of storage of the ASC it is necessary, to pay greater attention to the quality of the trasformer oil during installation (see Operating Instruction 1).

## 3 SITE INSTALLATION

### 3.1 AREA SPECIFICATION

The ASC standard type is intended for sites not protected against climatic conditions, being classified as middle climatic group areas M (CT, WT, Edr and MWDr) with an air temperature of  $-30^{\circ}$  to  $+40^{\circ}\text{C}$ , highest sea level of 1000m, pollution level corresponding to usual conditions of city industrial zones with industry spread over the whole area, further for areas with sand and dust occurrence including city areas, for sites protected against considerable vibrations and shocks.

If the ASC is installed in closed rooms a sufficient air circulation must be provided. A minimum of  $4\text{m}^3/\text{min}$  of air per 1kW of heat loss should be available. The heat loss value is mentioned in the Commercial and Technical documentation supplied with the ASC.

### 3.2 SITE SPECIFICATION

The plan of the site for ASC installation must be elaborated according to all relevant standards.

The most important are the following standards:

- General requirements for electric stations
- Requirements for sites with respect to building regulations, cooling, noise, fire prevention
- Conditions for protection against electric shock of both live and insulated parts
- Grounding in electric stations
- Operating conditions of electric networks with capacitive currents compensation
- Requirements for protection of electric machines

Note: For proper function of the Buchholz relay horizontal position of the ASC must be ensured (with maximum admissible tolerance of  $1^{\circ}$ ).

### 3.3 MOUNTING RADIATORS

The mounting of radiators out of the production site is carried out only in case of new ASC types of higher power rate (being transported without radiators- e.g. Type ZTC 4000) as well as in case of the necessary radiator replacement. Considering the imperfect sealing function of the flap valves NW80 of the tank used for the connection of radiators it is necessary to eliminate the leakage of oil of the tank before the removal of blind flanges. This can be obtained either by pumping oil out of the ASC tank for the necessary period making possible the mounting of radiators or by creating underpressure in the filled tank (ca 30 kPa) by means of a vacuum pump (for the mounting period). The second mentioned way is more convenient and also recommended by the manufacturer. The oil is pumped out through the lower outlet intended for ASC refilling (valve A31 or A40 or a slide valve; the valve or slide valve type is mentioned in the Commercial and Technical Documentation of the product). For assembly of a new ASC the vacuum pump can be connected across the flange of the Buchholz relay which (according to relay type) may have a dimension of Js25 Jt10 or Js50 Jt16.

The most advantageous place for the connection of the vacuum pump in the course of replacement of radiators of an assembled ASC is the flange of the drier after its removal.

The mounting of radiators of a new ASC has to be carried out prior to the fitting of the conservator. Before mounting radiators their blind flanges must be removed and the contact surfaces cleaned. After the measures preventing oil leakage have been taken the blind flanges of the closing flap valves NW80 of one radiator of the ASC tank have to be removed, the contact surfaces are to be cleaned and the seals put in place. For the connection of radiators the same connecting material used for the blind flanges is used again. Once the radiator is attached we have to open the flap valves NW80 and switch off the vacuum pump. In this way we have to fit on step by step all radiators. The checking of connection tightness has to be performed not before the ASC is assembled and the oil refilling finished.

Caution ! In case of storing radiators before mounting (see Article 2.2.2) it is necessary to pay greater attention to the drying of their interior. As a result of longer storage there may be condensed water inside the radiators which may deteriorate the refilled transformer oil. For this reason before mounting the radiators must be dried..

Note: For mounting also a convenient lifting mechanism must be available, e.g. truck crane.

The deaeration of radiators has to be carried out when refilling the transformer oil.

### 3.4 MOUNTING CONSERVATOR

In case of transport of a disassembled ASC the conservator is delivered in a wooden grating. Its fitting takes place not before the radiators have been mounted. For the transport the contact surfaces of the conservator piping flange as well as of the Buchholz relay flange of the cover of the ASC are to be provided with blind flanges. After their removal the contact surfaces have to be cleaned and the packings from the accessories case are put in place. The mounting of the conservator starts with screwing together the flange connecting the conservator with the Buchholz relay. Then we have to fix the conservator on the support of the cover (the needed screws nuts and washers are attached for transport to the support of the cover) and if the pipe between the conservator and the drier is not an integral part of the conservator it must be fitted on. The mentioned pipe is delivered in the grating together with the conservator except the client ordered a special outfit (see Article 2.2.2). In that case this pipe is an integral part of a provisional contact part attached on the tank of the transported ASC.

Caution ! In case of storing conservator before mounting (see article 2.2.2) it is necessary to pay greater attention to the drying of its interior. Due to the longer storage there may be condensed water inside the conservator what represents danger of possible deterioration of the refilled transformer oil. Therefore the conservator must be dried before mounting. In such case also the provisional connection between the flange of the Buchholz relay and the connecting pipe of the air drier must be removed before mounting.

Note: The drier mounting necessitates a suitable lifting device e.g. truck-crane.

### 3.5 MOUNTING BUSHINGS

Outside the manufacturing plant only bushings for ASC types ZTC 5000 for 110kV networks are mounted. The mounting instruction applies only to the as standard delivered bushings of the type ETF 550 or OTF 550.

During the transport the bushing is placed in a separate case. In addition the case contains the flange packing necessary for mounting.

Mounting procedure:

- Remove the blind flanges and the transport holder from the bushing flange of the ASC cover. The screw stock is intended to be used for the later reinstallation of the bushing (8 screws M12, nuts, washers)
- Remove the bolt fixing together with the spring sleeve from the blind flange. Secure the terminal bolt with the cable by means of a wire. The wire is intended for the bolt to be drawn through the bushing body. The screw stock and the sealing O-ring have to be used for the reassembly.
- After the spring sleeve has been released, take out the terminal bolt and draw it together with the connecting cable through the central tube of the porcelain bushing body. Before we have to put a rubber flange packing on the lower part of the bushing which is placed in the transport case.
- Put the sealing O-ring and the bolt holder on the terminal bolt and fix these parts on the top section of the bushing body.
- Fix the terminal bolt by means of the spring sleeve in order to obtain a distance of 90mm between the bolt fixation and its top edge
- Fix the bushing on the cover flange
- Carry out a visual check of the porcelain body as well as of other bushing parts.

Note: For mounting a suitable lifting device e.g. truck-crane is necessary.

The bushing deaeration has to be performed during the transformer oil refilling - see description in Operating Instruction 6.

### 3.6 MOUNTING THE AIR DRIER

When transporting the ASC the air drier can be placed:

- on the tank including the conservator connection - if the ASC is delivered as complete unit
- in a case together with accessories - if ASC is delivered in a partly disassembled condition but is not intended to be stored in such a condition before installation
- on the tank with a provisional connection to the flange of the Buchholz relay - if the ASC is delivered in a partly disassembled condition and will be stored in this condition for a longer time before installation (special requirement, see Article 2.2.2).

Assembly procedure: Clean the flange sealing surfaces of the connecting pipe. Add the rubber packing and fit on the drier. Fix the connecting piping by means of sleeves on tank holders. Add the drying agent according to the Operating Instruction 8. Fit on the drier to the ASC tank using the holder.

### 3.7 MOUNTING UNDERCARRIAGE ROLLERS

The mounting of the undercarriage is to be carried out before the final installation of the ASC on site. The mounting takes place according to the Operating Instruction 3.

### 3.8 OIL REFILLING - DEAERATION

In case the ASC is not transported in assembled condition, than also the transformer oil needed for refilling after the assembly is an integral part of the delivery. This oil is transported in

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barrels protected by gratings. The technical parameters of the for refilling used oil and the oil level adjustment are described in Operating Instruction 1. The ASC deaeration is carried out according to the instruction mentioned in the Operating Instruction 6.

Caution ! Before deaeration it is necessary to remove the arresting rubber insertion pieces of the float of the Buchholz relay.



## 4 THE ASC CONNECTION

The positions of bushings and their marking are shown in the size drawing of the Commercial and Technical documentation of the product.

According to the marking system used by the customer the bushings are marked as follows:

Main winding input bushing	D1	1.1	U
Main winding output bushing	D2	1.2	V
Bushings of the metering current transformer	k - I	k - I	k - I
Bushings of the auxiliary winding (metering winding)	M1 - N1 / N1.1	3.2 - 3.1 / 3.11	$V_m - U_m / U_{m1}$
Bushings of the secondary winding	M2 - N2	2.2 - 2.1	v - u

Caution ! There must be paid greater attention to the connection of the leads to bushings. The hexagonal nut used for tightening the protective cap and the bushing packing must not be loosen.

### 4.1 CONNECTING LEADS OF THE MAIN WINDING BUSHING

The input bushing has to be connected to the transformer neutral, the output bushing to the earthing system of the substation. The leads to bushings are designed in order to have a sufficient length and a corresponding cross-section. The connection to bushings is carried out by means of cable eyes or clamps with smooth and clean contact surfaces.

### 4.2 CONNECTING LEADS OF THE SECONDARY WINDING BUSHING

The leads are designed in order to provide sufficient length and corresponding cross-section. The connection is carried out by means of cable eyes or clamps with smooth and clean contact surfaces. For ASC provided with MA or MD2 drives the arrangement of bushings on the cover is according to the ASC type either free or the bushings are placed in a common housing together with bushings of other circuits. For ASC provided with a MD1 drive the bushings are placed always inside a housing and connected to the bus-bar system of the motor drive operating box.

### 4.3 CONNECTING LEADS OF BUSHINGS FOR AUXILIARY WINDING AND FOR SECONDARY CURRENT TRANSFORMER WINDING

The bushings of these circuits are placed always inside a housing and connected by cables to the bus-bar system of the operating box of the motor drive. The terminals of the secondary current transformer winding are short-circuited on this terminal board.

Caution ! The short-circuited terminals are allowed to be disconnected not before the measuring instrument has been properly connected !

### 4.4 PROTECTIVE INTERCONNECTION

There are 4 earthing points on the undercarriage designed in conformity with the DIN 48088-B-M12 and predetermined for junction of the protective interconnection system to the grounding system of the substation.

### 4.5 CONNECTION OF BOTH THE POWER SUPPLY AND ALARM CIRCUITS

The power supply system of 3x400/230V 50Hz as well as the alarm circuits wires are to be connected to the terminal board of the motor drive operating box according to the wiring diagram of the ASC which is an integral part of the Commercial and Technical Documentation of the product.

## 5 PUTTING INTO OPERATION

Putting the ASC into operation represents a complex of operations and checkings to be made on the ASC site before the ASC can be connected to the network. The output document is a record for the operator proving the equipment's suitability for operation.

### 5.1 CHECKING MECHANICAL PARTS

Checking the mechanical parts of an ASC represents the following items:

- removal of possible mechanical dirt from the surface of the ASC or its parts being caused by the transport or storage
- checking if the closing flaps of the radiator flanges are open
- visual control of the sealing function of all flanges of the Buchholz relay, radiators, conservator, oil valves, ASC tank, possibly also of the 110kV bushing and elimination of all contingent leakages
- checking whether the screw connections of brackets, radiators, flanges etc. are tightened

### 5.2 CHECKING ELECTRICAL PARTS

Checking the electrical parts of an ASC represents the following items:

- checking the leads of the corresponding bushings and their proper mechanic and electric workmanship
- connection of cables in the motor drive operating box in conformity with the wiring diagram
- proper run of the electric motor including the right function of both limit switches

Caution ! The undisturbed function of the ASC can be obtained only by keeping the right-hand phase sequence on the terminal board of the motor drive operating box.

- checking the manual remote control of the ASC
- checking the automatic function control of the ASC through a controller or by means of a substation control system (if available)
- control of a proper wiring and switching function of the resistor by the controller or by means of a substation control system (if available)
- measurement of insulation resistances
- checking of both mechanical and electrical condition of the protective interconnection system and earthing

### 5.3 CHECKING THE FUNCTION OF DEVICES

The checking consists in verification of the right function of the used devices. We have to check their adjustment, fault signalling including its function related to the controller or substation control system.

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The description of functions and settings of individual devices is mentioned in the Mounting Instructions 5.

Caution ! In order to ensure the right function of the Buchholz relay it is necessary to remove the float arresting rubber insertion pieces before any tests.

### 5.4 CONTROL OF THE OIL CHARGE CONDITION

The control of the oil charge condition consists of:

- quality test of the oil used 1)
- ASC deaeration (carried out in conformity with instructions mentioned in Operating Instruction 6)
- verification of the drying agent condition of the air drier (see Operating Instruction 8)
- control of the oil level inside the conservator which must correspond to the relevant ambient temperature (the setting of the oil level is to be carried out according to the Operating Instruction 1).

## 6 THE ASC CURRENT ADJUSTMENT

### 6.1 HAND OPERATED ASC ADJUSTMENT

First the ASC has to be adjusted at the minimum current value and connected to a „healthy“ network. In the course of gradual increase of the current adjustment of the ASC till the maximum value the corresponding voltage of the metering winding is measured. The maximum voltage of the obtained resonance curve corresponds to such a ASC current value, which is equivalent to the earth capacitance of the network. So with this current value the ASC inductance is tuned to the network earth capacitances and a resonance is established. The possible unsymmetry of the mentioned earth capacitances may result in a high increase of differences between phase to zero voltages of the network. This difference could be minimized by a partial ASC detuning.

### 6.2 CONTROLLER OPERATED ASC ADJUSTMENT

In hand operating mode first we have to break the tuned condition of the ASC by its detuning, i.e. we adjust a current value being different from the capacitive earth current of the network. After the reset command the controller must be able to readjust the ASC to the resonance condition again in conformity with the set controller parameters.

## 7 MAINTENANCE AND REVISIONS

During operation the ASC do not require special maintenance. In principle a short visual control and simple service tests will do.

### 7.1 THE ASC VISUAL CHECK

The manufacturer recommends to do this checking once within six months at least. It is to be done in operating mode from a safe place under observance of all safety rules. It consists of the following operations:

- general visual examination of the ASC. This means the control of all ASC sealing places being in sight. The found leakages must be eliminated according to the procedure mentioned in the Mounting Instruction 7.
- checking the oil level in the conservator. This oil level must correspond to the ambient temperature. If some correction of the oil level is necessary we have to proceed upon the Mounting Instruction 1.
- checking the drier charge level in the conservator. It consists in checking the colouring of the drying agent in the lower part of the drier. If the drying agent is rosy it must be replaced immediately or regenerated. So far the oil level in the lower part of the drier does not reach the marked level oil must be refilled. In both cases we have to proceed according to the Mounting Instruction 8.

### 7.2 OPERATING TESTS

The manufacturer recommends to perform these tests once within two years at least. Before starting works it is necessary to meet all safety rules. These tests consist of:

- control of all sealing places of the ASC as mentioned in section 6.1.
- examination of the coating condition (painting). Possible dirt will be removed from the ASC surface and the control of the anticorrosive protection will be carried out. The damaged areas must be perfectly cleaned to the blank metal. Then a layer of zinc is to be applied and coated with the priming coat. After its becoming dry we do regrounding and finally we put on the top coat.
- examination of bushings. The porcelain bodies have to be cleaned, the damaged insulator bodies (hair cracks, surface damages) must be immediately replaced. The contact surfaces must be cleaned of corrosion, provided with contact vaseline and the screw connections must be tightened.
- examination of earthing points. The contact surfaces must be cleaned of corrosion, provided with contact vaseline and the screw connections must be tightened.
- insulation resistance measurement.
- checking of the oil condition. In the same way as in the section 6.1 described the oil level in the conservator has to be checked. In addition the sample of the oil should be taken and its parameters are measured. In the course of this procedure we have to follow the instructions mentioned in the Mounting Instruction 1.

- motor drive examination. Function tests of the motor drive have to be carried out. The maintenance should be done according to the Instruction Manual for the used motor drive type.
- examination of control devices. We have to clean the oil level gauge glass tube, device's housings and its scales. We must verify the right switching function of contacts of devices. The description of existing signals is included in the Operating Instruction 5. In case of the gas accumulation in the chamber of the Buchholz relay it is advisable to analyse the gas sample in order to specify the cause of its occurrence. Also the function test of the Buchholz relay according to the Instruction Manual must be done. The mentioned Instruction Manual is an integral part of the Commercial and Technical documentation.
- examination of the drier as mentioned in Article 6.1
- examination of radiators. We have to verify the right sealing of both radiators and closing flanges. Possible leakages should be eliminated immediately in conformity with the Mounting Instruction 7.

### 7.3 REVISIONS

The revision of ASCs is carried out by the manufacturer in his works and is based on the client's order. With respect to the results of operating tests the revisions are recommended to be performed once in 15 years at least. The goal of a revision is to evaluate the condition of the ASC. All electric parameters, extent of mechanical wear and check of the transformer oil have to be carried out. Upon agreement with the client a replacement of defect or worn parts is made. In the framework of the revision further modifications corresponding to the actual ASC outfit standard can be realized.





## OPERATING INSTRUCTION 1

### INSULATING OILS FOR ARC SUPPRESSION COILS

The instruction determines the relevant technical parameters, storage conditions, conditions for oil refilling, ways how to monitor quality and make tests of insulating oils used as charge of arc suppression coils.

#### 1 GENERAL

At the time of the delivery of the the ASCs manufactured by the EGE Company they are fully charged with the insulating oil. The exception represent ASCs of higher power rate (Type ASR3.2, ZTC4000 and ZTC5000) transported without conservator or without radiators or bushing. For these ASCs the insulating oils are delivered in barrels as a part of the delivery.

#### 2 TECHNICAL PARAMETERS

For ASC filling the following insulating standard Shell oils are used:

- Shell 4610
- Shel Diala D
- Shell Diala DX

On special request the ASC can be delivered with other insulating oil e.g.:

- ESSO Company, oil UNIVOLT 52
- ARAL Company, oil ISOLANT TT
- BP Company, oil TECHNOL US3000

All these oil types meet the requirements of the IEC 296 Standard, class II or IIA as well as of the Standard DIN 57370, section 1/ VDE 0370, section 1, class A. The type and the technical parameters of the insulating oil used for a concrete delivery are an integral part of the Technical Documentation of the order.

#### 3 TRANSPORT AND STORAGE

The insulating oil necessary for the refilling of the ASC is delivered in barrels protected against damage by special grating. For delivery the barrels are provided with packings. In the course of storage it is necessary to follow the rules related to the protection of environment in order to prevent the earth and water resources contamination. Also confusion between oils and other products during storage must be avoided (also a new and used oil have to be distinguished in a consequent way). The storage rooms and barrels must be kept tidy. Before filling the ASC there must be taken samples of oil from barrels and the control of its quality has to be carried out. We have to pay greater attention to the oil quality before filling an ASC. It is based on the

danger of the possible deterioration of the oil during a long term storage in a partly disassembled condition. The works related to the oil storage and oil handling must be done only through trained personal.

## **4 OIL FILLING AND OIL LEVEL ADJUSTMENT**

Before starting works we have to check connection fittings and the cleanness of connecting hoses. It is necessary to pay greater attention to the conservators or radiators of ASCs stored in a partly disassembled condition and check them for possible condensed water. In such a case the water must be dried in order to avoid the deterioration of the refilled oil.

Note: For oil refilling we need an oil pump of 45l/min and 5m delivery, connecting flanges, connecting hoses and connecting fixtures for A31, A40 valves. The types of the used connecting fittings are mentioned in Commercial and Technical Documentation of the order.

### **4.1 Oil filling**

#### **4.1.1 Oil refilling**

The oil refilling is made through the loweroutlet intended for oil refilling or through the lower oil sampling valve DN15 (Standard DIN 42568) by means of an oil pump. According to the ASC accessories the lower outlet can be represented by A31 or A40 valves (Standard DIN 42568) or by a gate valve (Standard DIN 3352 T11) with nominal inside diameter corresponding to the customer's requirement. Once the oil refilling is carried out with installed air drier, the top filling neck of the conservator must be open. In case the ASC is provided with radiators than we have to check before oil refilling whether the closing flaps NW80 used for radiator connections are open. The oil is filled up to the oil level gauge mark corresponding to the relevent temperature. The parameters of the new refilled oil must reach at least the values mentioned in Table 1 - section A. After the oil filling the deaeration of radiators, Buchholz relays and bushings as prescribed in Operating Instruction 6 is to be carried out. If no drier has been fitted on during oil filling it is to be fitted immediately.

#### **4.1.2 Filling an empty ASC**

The filling of an empty not completed ASC on the customer's site is practiced after it was necessary to discharge fully the ASC oil for service or repair works. In such cases the refilling is made only by means of an filtering equipment. Before filtering we have to perform tests of the oil prescribed by the Table 2 and we have to carry out its regeneration or to use a new oil in case the measured values do exceed the given limits. The filling procedure is mentioned in section 4.1.1. „Oil refilling“ (only for filling not a pump but a filtering equipment is to be used).

### **4.2 Oil level adjustment**

Before starting the oil level adjustment we have to read the transformer oil temperature under the ASC cover taking into consideration the possible oil temperature rise just in this layer under influence of direct solar radiation or through the preceding ASC operation. The oil level inside the conservator must correspond to the level found for the measured temperature. The conservator oil refilling is to be made through the filling neck manufactured according to the

standard DIN 42 553-D. The discharge of the oil from the conservator is to be done through the outlet valve A22 (standard DIN 42 551) situated in its lower part. For refilling the oil must show either the minimum values given in Table 1 - Section A for new till the present time not operated ASCs or values given in Table 1 - Section B for ASCs which have been stored. For an already operated ASC the values of Table 3 are relevant.

Caution ! The oil level gauge is not intended for temperature reading.

### **4.3 Oil level lowering**

The lowering of the oil level is usually necessary for following service works :

- replacement of the bushing body or bushing packings
- elimination of cover leakages
- elimination of conservator leakages
- leakage elimination of the Buchholz relay and the connecting piping

In cases mentioned above the oil is usually discharged to the level of 100mm below the cover.

The complete oil discharge is practiced in following cases:

- for revision of the removable ASC part
- for elimination of tank or tank fitting leakages

The discharged oil can be put into barrels or into a tank if its quantity is big. In both cases the deterioration of oil through residues of other products must be avoided. The oil discharge is carried out through the lower outlet valve intended for oil refilling. Before starting the oil discharge the filling neck on the top of the conservator must be open.

### **4.4 Before putting into operation**

Before the ASC network connection the ASC must stay in idle condition for 24 hours. After this period we have to check again the deaeration, oil level and carry out the examination of all flanges and sealing surfaces for oil leakages. Possible oil level deviations in the conservator have to be eliminated. Oil samples should be taken. For new installed ASC the oil must show at least the values given in Table 1 - Section C. For an already operated ASC the values of Table 3 are relevant.

## **5 TAKING OIL SAMPLES**

The oil samples are recommended to be taken in the following way. Before taking oil samples the place of sampling (valve) and other subsidiary means (vessels or cups) must be properly cleaned and dried. The samples are to be taken as quick as possible so that the taken oil sample could not absorb any moisture. During taking samples the oil has to run down on the inner side of the cup. Any oil foaming or air absorption should be avoided. Before the proper sampling about 3 l of oil should be let out. The oil sample is taken either directly into an oil cell with metering electrodes in case that only electric strength in the customer's site is measured or into a glass cup with ground neck. The minimum taken volume makes 1,5 l. When taking samples the cell and oil must have the same temperature value. So we can eliminate the condensation of air humidity and the subsequent deterioration of the oil sample. When

taking samples we have to record also the oil temperature so that the temperature effect for the saturation of oil with water could be taken into account. The taken oil sample must be properly marked. Till the execution of tests the sample should be stored at the room temperature and protected against open light. The tests are recommended to be done within five days after the oil samples have been taken. The sampling must be made in conformity with recommendations published in IEC 475 (ČSN 34 6433).

## 6 TESTS

The extent of oil tests before and during the operation is mentioned in tables in section 8 - Parametres of Insulating Oils. The scope and execution of tests takes place according to the rules IEC 296 or to national standards VDE 0370 part 1, part 2 and ČSN 34 6433.

## 7 MONITORING THE OIL QUALITY

Insulating oils have to fulfill two principal functions - the insulating and the cooling one. If the oil should fulfill the insulating function the water absorbed in the insulating system oil-paper must be dissolved and no water emulsion or free water may arise. The oil must also not be oversaturated with gas and must not enclose conductive impurities. For good cooling function it is important that the thermal and oxidizing aging does not exceed the limit opening the possibility for creation of sludges and sediments. For evaluation of the aging effect in the course of ASC operation we have to carry out periodical oil level controls. The recommended test period is given in Table 4. The recommended oil limit values for ASC in operation are given in Table 5.

## 8 INSULATING OIL PARAMETERS

### 8.1 The checked parameters of new oils when filling new ASCs.

TABLE 1.

Parameter	A - for oil refilling without preceeding ASC storage	B - for oil refilling with preceeding ASC storage	C - before putting into operation
purity	clear	clear	not checked
break-down voltage	$\geq 60\text{kV}/2.5\text{mm}$	$\geq 60\text{kV}/2.5\text{mm}$	$\geq 60\text{kV}/2.5\text{mm}$
water content	not checked	$< 10\text{g/t}$	not checked

## 8.2 Limit parameters of the used oils for repairs

TABLE 2.

Parameter	Units	Values
surface tension	mN/m	> 35
water content	g/t	≤ 25
acid number	mg KOH/g	< 0,10
resistivity	Ohm.cm.10 <sup>10</sup>	≥ 200
loss factor tan δ at 90°C	---	< 0,10

## 8.3 The checked parameters of used oils for refilling of repaired products

TABLE 3.

Parameter	for filling of repaired ASCs
brak-down voltage	≥ 55 kV/2.5mm
water content	< 15g/t
total gas content	< 2%

## 8.4 Recommended time periods for oil condition monitoring

TABLE 4.

Parameter	middle-term period - 2 years	long-term period 4 years
break-down voltage	+	+
surface tension	+	+
water content	-	+
acid number	-	+
resistivity	-	+
loss factor tan δ at 90°C	-	+
aging coefficient	-	+
total gas content	-	+
inhibitor content	-	+
1)		

**8.5 Recommended oil values under operation mode**

TABLE 5.

Parameter	Units	Values
break-down voltage - for HV	kV/2.5mm	$\geq 30$
break-down voltage - for extra HV	kV/2.5mm	$\geq 40$
surface tension	mN/m	$> 25$
water content	g/t	$\leq 35$
acid number	mg KOH/g	$< 0,30$
resistivity	Ohm.cm. $10^{10}$	$\geq 50$
loss factor $\tan \delta$ at 90°C	---	$< 0,50$
aging coefficient	---	$< 0,08$
inhibitor content 1)	%	$> 0,10$

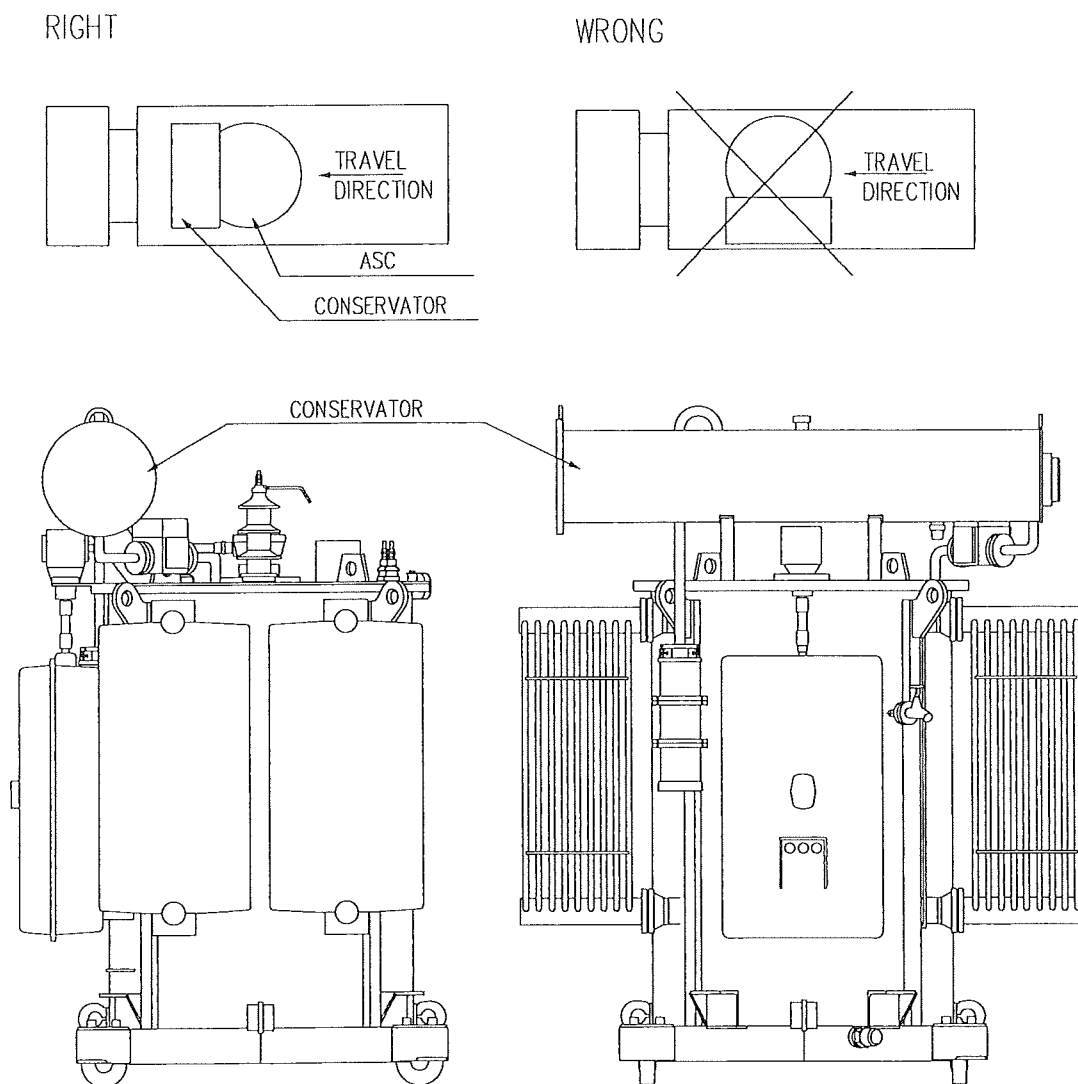
1) Only inhibited oils

## OPERATING INSTRUCTION 2

### PLACEMENT AND SECURING THE LOAD FOR TRANSPORT

The ASC should be placed on the load area of a vehicle in order to get the conservator (tank situated in horizontal position above the ASC cover) turned crosswise to the travel direction (see picture 1). The ASC is usually attached at 4 places by means of ropes fixed in suspension eyes situated below the flange providing the connection with cover.

Picture 1. Placement of an ASC on the loading area of a vehicle.



The choice of a suitable vehicle, list of transport units as well as the way of loading and handling the transport units are to be carried out in conformity with article 1. of „General Operating Instructions for ASCs“.





## OPERATING INSTRUCTION 3

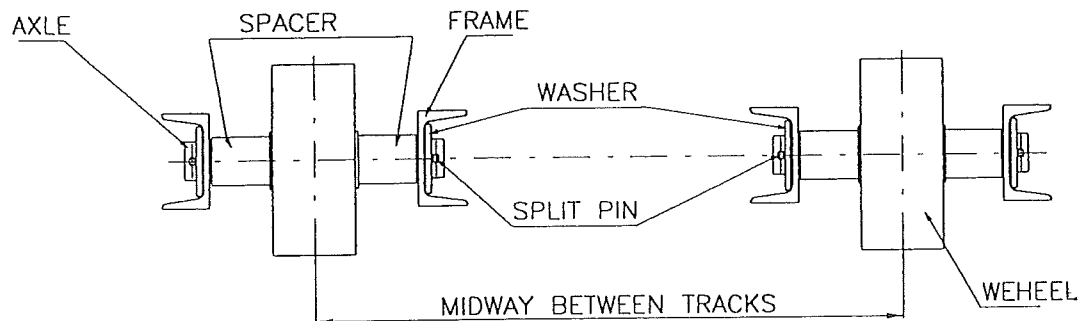
### FITTING THE ASC UNDERCARRIAGE ROLLERS

The ASCs are transported with disassembled undercarriage rollers. The Rollers together with other parts and accessories are boxed. For site installation the undercarriage parts have to be unpacked and mounted. During this procedure the ASC is suspended by crane at suspension eyes (see Table 2, Article 1.3 of „General Operating Instructions for ASCs“) low above the earth. The fitting procedures of used roller types are specified in this instruction.

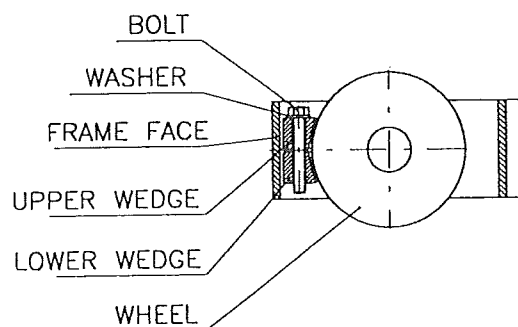
#### 1. SMOOTH ROLLERS MOUNTED IN A FRAME

The way of mounting smooth rollers in a frame is illustrated in picture 1a: The roller shaft has to be inserted from one side into the opening in undercarriage frame and subsequently we put on the first distance piece the roller and the second distance piece. The shaft in the frame is locked on both sides by washers and split pins. The blocking of rollers (preventing the ASC movement) is made by means of two braking wedges (boxed) put between the roll and the undercarriage front and tightened together by screw M12x80, see picture 1b.

Picture 1a. Mounting the smooth rollers in a frame



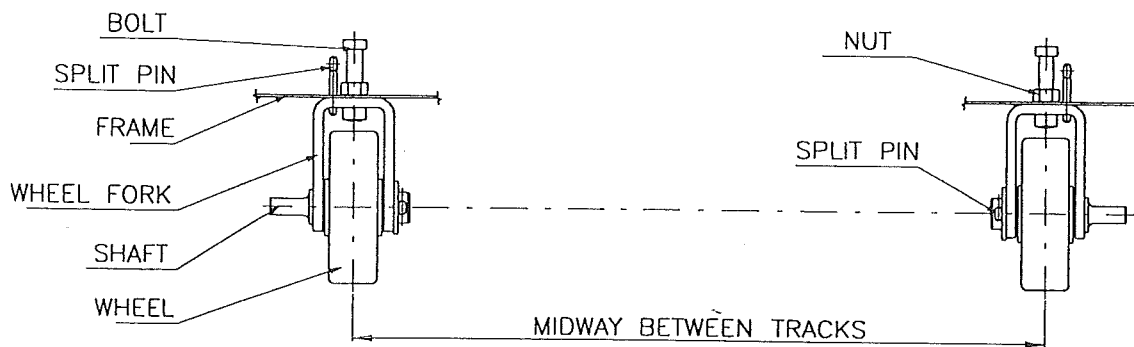
Picture 1b. Locking the smooth rollers in a frame



## 2 SMOOTH ROLLERS IN FORKS

The way of mounting smooth rollers into forks is illustrated in picture 2. The roller fork with shaft is boxed as an assembly. This assembly has to be screwed into the undercarriage frame by means one screw M16x75, should be fixed by a counter nut and locked in the right position by a split pin 5x60. The locking of rollers (preventing the ASC movement) is made by tightening the radial screw M16x75 with the required braking effect.

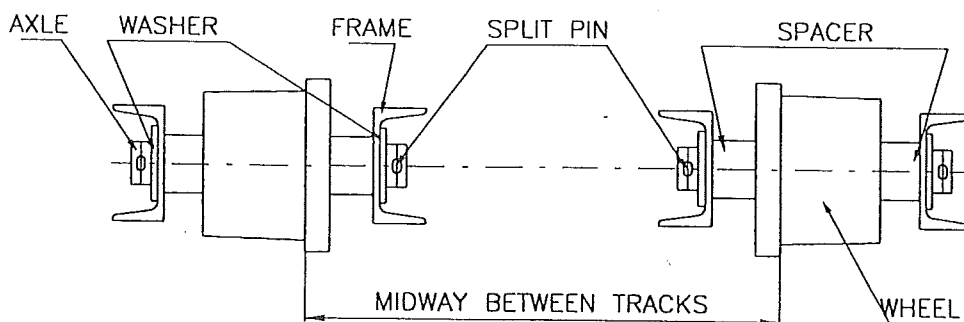
Picture 2. Mounting smooth rollers into forks



## 3. TYRE ROLLERS IN FRAME

The way of mounting smooth rollers in a frame is illustrated in picture 1a: The roller shaft has to be inserted from one side into the opening in the undercarriage frame and subsequently we put on the first distance piece, the roller and the second distance piece. The shaft in the frame is locked on both sides by washers and split pins. The blocking of rollers (preventing ASC movement) is made by tightening the radial undercarriage screw M20x70 with the required braking effect.

Picture 3. Mounting smooth rollers into a frame



In the course of assembly the axis spacing and the orientation of rollers should be checked. For that reason the worker carrying out this operation must have a size drawing being part of the Commercial and Technical Documentation of the product.

## OPERATING INSTRUCTION 5

### SIGNALS OF DEVICES USED IN ASC SERVICE

The ASC is equipped with monitoring devices as required by the customer. Their connection is made according to the wiring diagram disponible both in the control box as well as in the Commercial and Technical Documentation of the product. The following table contains the summary of individual devices and specification of possible cause of their occurrence.

#### 1. OIL LEVEL GAUGE (magnetic, tubular with contacts)

Device Signal	Cause	Cause clearing notes
„minimum“	Extremly low ASC temperature (caused by extremely cold weather)	
	Existing ASC leakage	Identify and eliminate its cause. Refill the oil into ASC.
„maximum“	The oil level reached the value corresponding to the highest admissible ASC temperature	
	Excessive oil quantity	Discharge some oil from the ASC

#### 2. OIL LEVEL DETECTOR

Device Signal	Cause	Cause clearing notes
„warning“	Extremly low temperature (caused by extremely cold weather)	
	Existing ASC leakage	Identify and eliminate its cause. Refill the oil into ASC.

#### 3. THERMOMETER

Device Signal	Cause	Cause clearing notes
„minimum“	Note: This signal contact is a part of a standard delivery and is at the customer's free disposal	
„maximum“	The ASC temperature approaches to the maximum admissible oil temperature. At delivery a closing temperature of 105°C is set.	Do monitor the temperature rise, avoid the oil overtemperature.

## SIGNALS OF DEVICES USED IN ASC SERVICE

### 4. THERMOSTAT

Device Signal	Cause	Cause clearing notes
„warning“	The ASC temperature approaches to the maximum admissible oil temperature. The recommended temperature setting makes 105°C, the actual setting for the delivery is mentioned in the test certificate.	Avoid the oil overtemperature

### 5. BUCHHOLZ RELAY

Device Signal	Cause	Cause clearing notes
„warning“	Air or gas accumulation inside the device's chamber for following reasons:	
	a) Low oil level in the ASC (caused by extremely cold weather or leakage)	Eliminate the possible leakage. Refill oil into ASC
	b) Relay not deaerated	Deaerate the relay
	c) Liberation of gas in the ASC	Further measures have to be discussed with the manufacturer
It is not necessary to put the ASC immediately out of service but we have to find at once the cause of this signal /see items a) to c)/ and eliminate it.		
„disconnecting“	Case of serious damage: a) insulator damage b) electric arc incidence c) winding fault d) low oil level inside the ASC	<b>The ASC can not be operated any more, the manufacturer must be advised immediately</b>

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## OPERATING INSTRUCTION 6

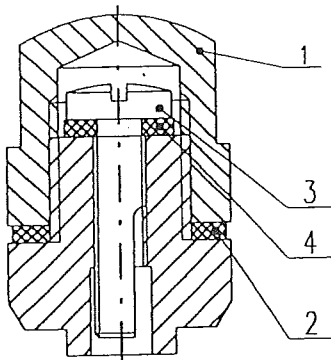
### DEAERATION

Before putting the ASC into operation both when installing a new or a repaired ASC, it is necessary to carry out its deaeration in order to ensure a fail-safe function. According to the design, outfit and ASC type the following parts have to be successively deaerated: radiators, HV and extra HV bushings, and Buchholz relay. The bushings corresponding to the standard DIN 42530 (1kV) and standard DIN 42539 (3kV) are not to be deaerated.

#### 1. DEAERATION OF RADIATORS

The deaeration of radiators is to be carried out only for radiators manufactured in conformity with the standard DIN 42559. Every radiator body has a de-aerating screw (size 6 according to the DIN 42558) - see picture 1.

Picture 1. De-aerating radiator valve



- 1 - covering nut
- 2 - covering nut packing
- 3 - de-aerating screw
- 4 - de-aerating screw packing

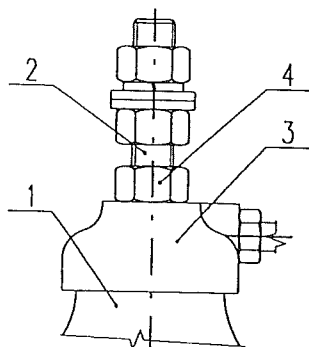
#### Deaeration procedure:

Do unscrew the covering nut (1) and loosen the de-aeration screw (3). If oil without air holes runs out tighten the screw again. Screw in back the covering nut. Clean the radiator of oil residues.

## 2. BUSHINGS

2.1 HV bushings manufactured according to the standard DIN 42531 (10, 20, 30kV - 250A). These bushings are not provided with a de-aerating screw- see picture 2.

Picture 2. Bushing DIN 42531



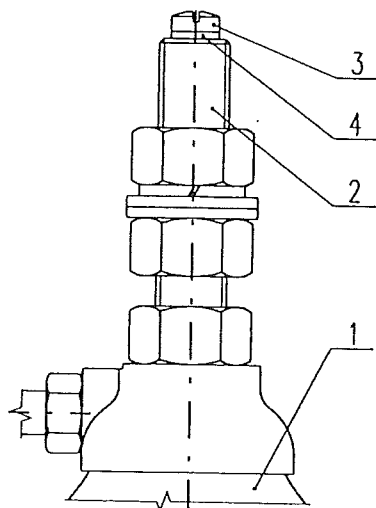
- 1 - porcelain bushing body
- 2 - bushing bolt
- 3 - cap
- 4 - nut M12

Deaeration procedure:

Wind round the porcelain body of the bushing (1) with textiles. Loosen the nut M12 (4) of the terminal bolt (2) which draws the bushing together. Loosen the cap (3) with packing. If oil without air holes runs out tighten the tightening nut (4). Clean the porcelain body carefully of oil residues.

2.2 HV bushings manufactured according to the standard DIN 42532 (10, 20, 30kV - 630A). At the end of the terminal bolt (M20) the bushings are provided with a de-aerating screw M8 including packing - see picture 3.

Picture 3. Bushing DIN 42532



- 1 - porcelain bushing body
- 2 - bushing bolt
- 3 - de-aerating screw
- 4 - packing

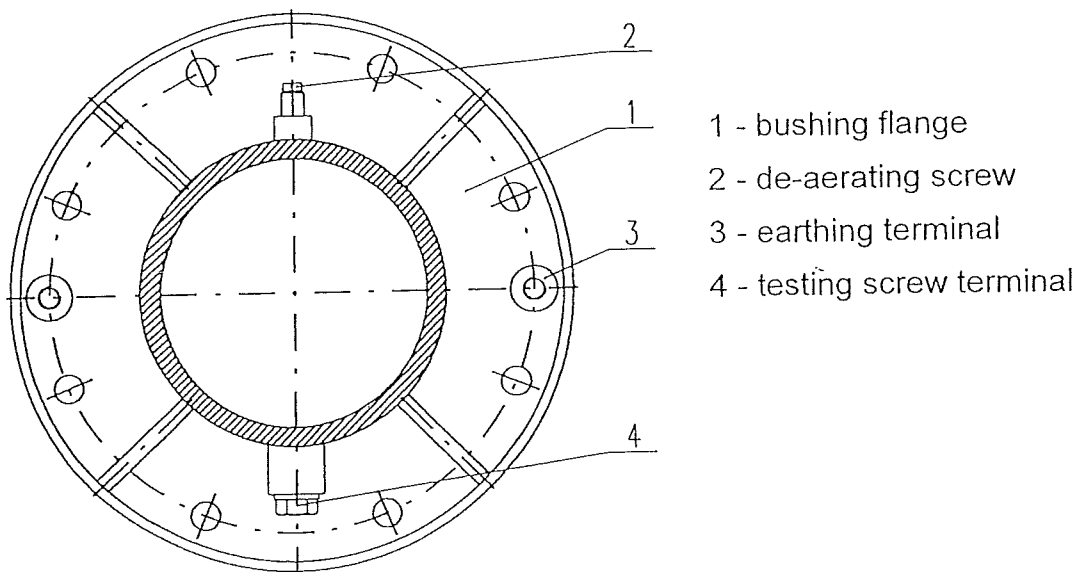
## DEAERATION

### Deaeration procedure:

Wind round the bushing porcelain body (1) with textiles and loosen the de-aerating screw (3). If oil without air holes runs out tighten the screw again. Clean the porcelain body carefully of oil residues.

2.3 Extra high voltage ASC bushings for 110 kV networks. The usually delivered bushing types have the de-aerating screw in the lower part on the fixing flange - see picture 4.

Picture 4. 110kV bushing flange



### Deaeration procedure:

Wind round the lower fixing flange of the cover (1) with textiles and loosen the de-aerating screw (2). If oil without air holes runs out tighten the screw again. Clean the fixing flanges carefully of oil residues.

## 3. BUCHHOLZ RELAY DEAERATION

The deaeration procedure is described in details in the Operating Instruction of the Buchholz relay being part of Commercial and Technical Documentation of the product which is delivered with every ASC.

Caution ! Before deaeration the arresting rubber insertion pieces of the Buchholz relay floats have to be removed.





## OPERATING INSTRUCTION 7

### LEAKAGE ELIMINATION

Leakages usually bring about oil stains on the defect place. They may be caused by loosen screws of the flange connection as well as by a damaged packing or defect porcelain body of bushings. In case of occurrence of any other sort of leakage (e.g. weld leakage) the manufacturer must be informed at once. It is necessary to pay special attention to the elimination of leakages and to see to a remedy immediately after they have been discovered. Defects of long duration may bring about more substantial damages. Before starting the remedy works the ASC has to be disconnected of the electric network and all measures necessary for safety of work should be taken.

#### 1. TIGHTENING THE SCREW CONNECTIONS

In simplest case of a fitting leakage the tightening of the respective connection screw on the concerned place would do. If the oil continues to leak the cause may be the damaged packing which must be replaced by a new one.

#### 2. REPLACEMENT OF DAMAGED PACKING

- lower the oil level according to the Operating Instruction 1, Article 4.3
- disassemble parts of the affected place
- take out the damaged packing
- clean and degrease the sealing surfaces before using a new packing
- after fitting back the concerned part refill the oil according to the Operating Instruction 1, Article 4.1
- when replacing the damaged packing of radiator flanges it is recommended for disassembling and fitting back radiators to proceed according to the procedure described in Article 3.3 of General ASC Operating Instructions.
- carry out deaeration in conformity with the Operating Instruction 6

#### 3. REPLACEMENT OF DAMAGED PORCELAIN BUSHING BODY

- disconnect the power supply
- lower the oil level according to the Operating Instruction 1, Article 4.3
- loosen screw connections fixing the bushing and take out the porcelain body
- before installing a new porcelain body and new packing between the bushing and the cover, the sealing surfaces have to be cleaned and degreased properly
- after the reassembly refill the oil according to the Operating Instruction 1, Article 4.1
- restore the power supply
- carry out deaeration according to the Operating Instruction 6



# OPERATING INSTRUCTION 8

## AIR DRIER

The air drier is used in order to eliminate the humidity of the air drawn into the interior of the ASC. The air is drawn into the ASC due to volume reduction of the oil charge (through changes caused by oil thermal expansivity during temperature drop). The drier prevents the oil quality deterioration under influence of air humidity.

Picture 1. - Drier

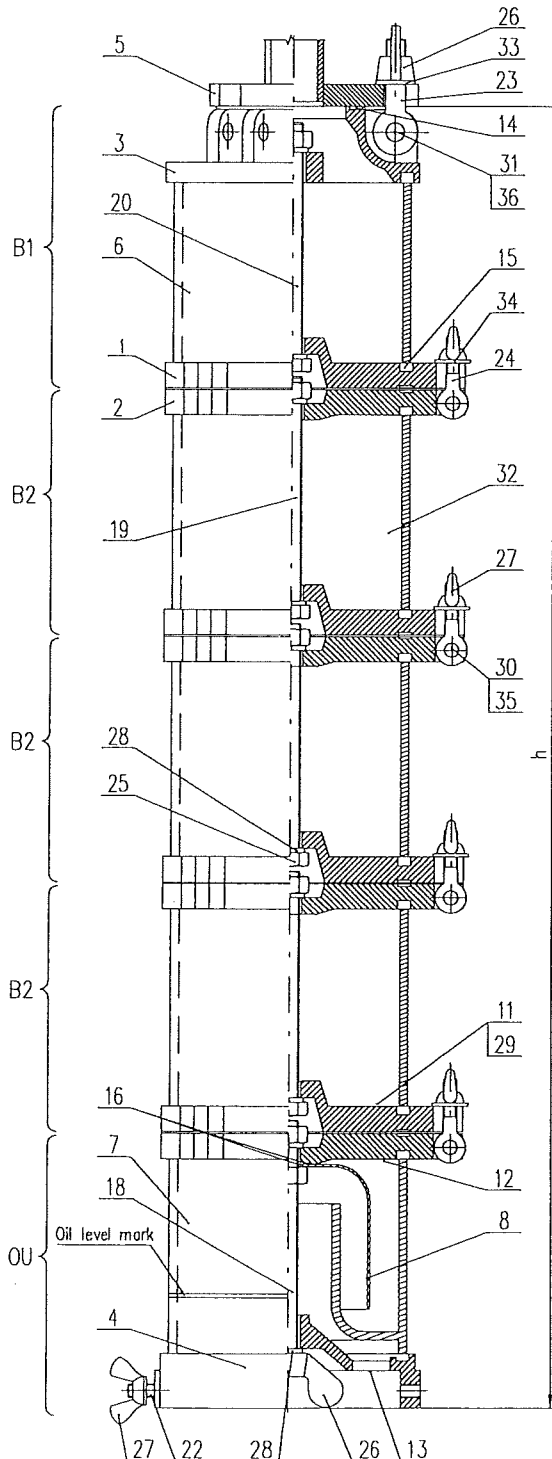


Table 1 - Drier specification

No	part name	designation
1	reservoir bottom	DIN 42562- 1
2	reservoir cover	DIN 42562- 2
3	drier cover	DIN 42562- 3
4	drier bottom	DIN 42562- 4
5	drier flange	DIN 42562- 5
6	cylinder	DIN 42562- 6
7	oil closing reservoir	DIN 42562- 7
8	bell	DIN 42562- 8
11	screen	DIN 42562- 11
12	screen	DIN 42562- 12
13	screen	DIN 42562- 13
14	drier packing	DIN 42562- 14
15	reservoir packing	DIN 42562- 15
16	flat packing M1-250	DIN 42530
18	bolt M12x150	DIN 976 A2-70
19	screw M12x150	DIN 931 A2-70
20	screw M12x140	DIN 931 A2-70
22	stud bolt M8x30	DIN 939 A2-70
23	eye bolt M12x55	DIN 444 A2-70
24	eye bolt M8x40	DIN 444 A2-70
25	nut M12	DIN 934 A2-70
26	wing nut M12	DIN 315 A2-70
27	wing nut M8	DIN 315 A2-70
28	spring washer 12	DIN 127
29	rivet 2.5x5	DIN 1476
30	retaining ring 8x0.8	DIN 471
31	retaining ring 10x1	DIN 471
32	drying agent	-
33	washer 13	DIN 125
34	washer 8.4	DIN 125
35	pin	DIN 42562- 35
36	pin	DIN 42562- 36

Table 2 - Drier sizes

size	L1	L2	L3	L4
drier agent weight /kg/	1.2	2.4	3.6	4.8
high h /mm/ ± 3	342	489	636	783
drier total weight	9.2	12.6	16.3	20.0
drier assembly	reservoir B1	1	1	1
	reservoir B2	-	1	2
	oil closing OU	1	1	1

## 1. DESIGN AND CHARACTERIZATION

The ASCs are delivered with air driers designed according to the standard DIN 42562. It consists of several parts - reservoir B1, reservoir B2, and oil closing OU (see picture 1.). The reservoirs B1 and B2 contain each 1.2kg of drying agent, the oil closing is charged by transformer oil. The air is driven into the drier through an oil closing OU. This one prevents both the permanent contact of the atmospheric air with drying agent and penetration of dust particles. The drier's size (see Table 2) i.e. the quantity of drying agent given by the number of reservoirs B2 depends both on the air humidity value of the working surroundings and of the oil charge quantity i.e. on the ASC size. Each of reservoirs consists of bottom (pos.1 or 4), glass cylinder (pos.6 or 7), cover (pos.2 or 3), screen (pos.11 or 12 and 13) riveted on the bottom, and packing (pos.15). After screw tightening (pos.18 or 19 or 20) the reservoir is to be charged with the drying agent quantity mentioned above. Before assembly the oil closing reservoir (pos.7) is to be filled with transformer oil up to the oil level mark (see picture 1). The individual reservoirs are coupled together hermetically and fixed by swinging eye screws, wing nuts (pos.23 and 26) and packings (pos.14) on the conservator flange.

## 2. DRYING AGENT

As drying agent a loose material with grain of very good absorption capacity is used. In active condition the grains are of an orange colour, after saturation with humidity they turn colourless. This process is a reversible one and for restoration of a proper function of the drying agent a regeneration (specified in section 3) instead of its replacement may be sufficient.

## 3. REPLACEMENT AND REGENERATION OF DRYING AGENT

First the dismantling of the drier in conformity with the procedure mentioned in section 1 has to be carried out. The drying agent saturated with humidity is to be arranged in a thin layer and dried by warming up to 130°C to 160°C until the grain colour has changed. The resulting colour of the regenerated agent must be orange.

## 4. REPLACEMENT OF OIL FILTRE CHARGE

The manufacturer recommends to replace the charge of the oil closing always at the occasion of its cleaning. Similarly as described in section 1 the oil closing reservoir is dismantled. Before filling the new transformer oil the reservoir has to be perfectly cleaned and degreased.