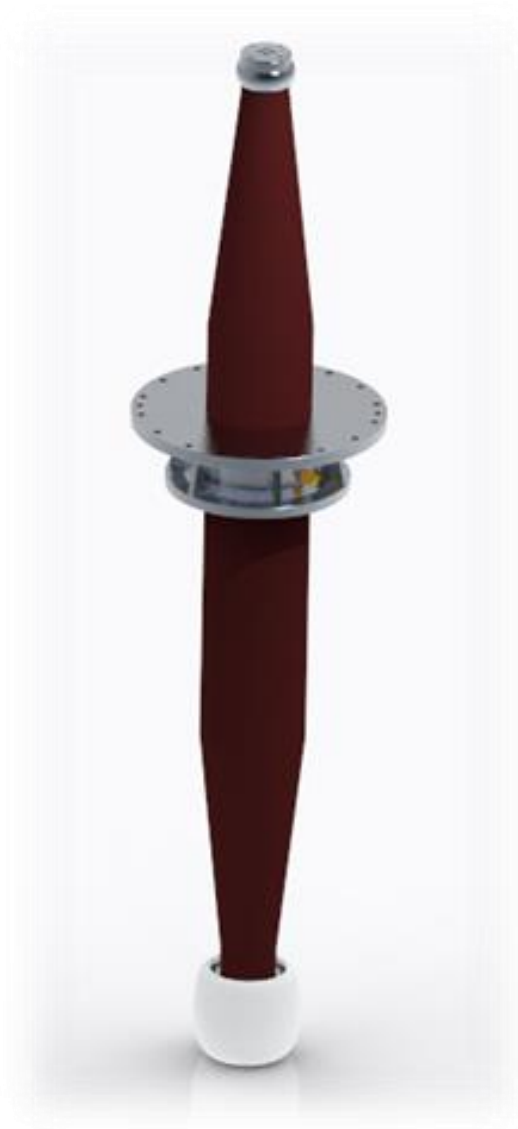




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**OIL TO SF<sub>6</sub> BUSHINGS SERIES POBR  
VOLTAGE FROM 72,5 TO 420 kV**





# STORAGE, OPERATING AND MAINTENANCE INSTRUCTIONS

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## 1. DESCRIPTION

### 1.1 GENERAL

These instructions are applicable to resin impregnated paper condenser type bushings of series:

“POBR” Rated voltage 72,5 to 420 kV

according to IEC 60137 and IEC 62271-211 Standard. Instructions give all general information to be followed from the receipt of bushings until their installation on the transformer. Other information is given regarding their service and maintenance.

These bushings are manufactured and tested in compliance with Standards IEC 60137 and IEC 62271-211 “Insulated bushings for alternating voltages above 1000 V”.

Design, components, and manufacturing technology guarantee an average lifetime longer than 30 years, in normal operation conditions.

The designation of the bushing is made as in the following example:

POBR.145.650.2000

P	Condenser bushing (“P” from Italian word “Passante”)
OB	Normal tail type, oil to SF <sub>6</sub>
R	Epoxy resin impregnated paper technology (RIP)
145	Rated voltage (in kV)
650	BIL – Basic Insulation Level (in kV)
2000	Rated current (in A)

### 1.2 SAFETY

This manual must be available to the personnel responsible of the installation, operation, and maintenance of the bushings.

The installation, operation, and maintenance of the bushing may present conditions of no safety and it is necessary to follow carefully specific procedures and instructions. No compliance with these procedures and instructions can involve very severe and dangerous conditions for the personnel and the property.

### 1.3 TECHNICAL CHARACTERISTIC

These bushings are capacitance-graded type, resin impregnated paper type (RIP), designed for operation one side immersed in the transformer oil, the other one in SF<sub>6</sub> gas for GIS application.

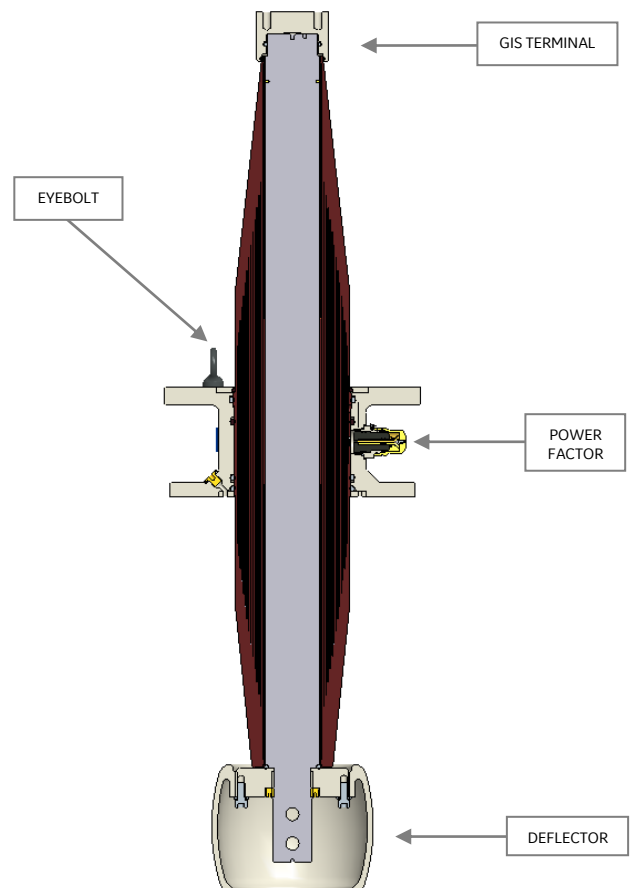
The insulation core of the POBR is produced by winding crepe paper onto a central rod, with aluminium foil insert

for electrical stress control. The manufacturing process is optimized to give a partial discharge free bushing with low dielectric losses.

This condenser execution improves radial and longitudinal distribution of electric gradients.

Versions with earthed under flange length in transformer oil side for CT accommodation are available upon request.

The schematic design is showed in figure 1.



**Fig. 1**

Bushings of this series can be mounted in every position.

The flange is equipped with the following accessories:

- Power Factor tap
- Lifting holes
- Name plate



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#### 1.4 TYPE OF DIELECTRIC

Under vacuum resin impregnated paper, provided with coaxial Al foils to control the electrical field distribution inside the dielectric.

#### 1.5 NAME PLATE

Each bushing is provided with a name plate, with serial number and all the electrical data, in accordance with the prescription of IEC Standards.

The plate (fig. 2 a) is made of aluminium and it is riveted to the flange. On the plate the following information are indicated:

1. Serial number
2. Month and year of production
3. Type of bushing
4. Standard reference
5. Rated frequency
6. Max. system voltage
7. Insulating voltages
8. Rated current
9. Measured main capacitance
10. Measured capacitance of test tap
11. Measured dissipation factor
12. Max. mounting angle (not filled)
13. Weight

	<b>PASSANTE-VILLA</b>
N. <input type="text"/>	<input type="text"/>
PASSANTE-BUSHING-TRAVERSEE-DURCHFUEHRUNG	
TYPE <input type="text"/>	
⊕ STD REF. <input type="text"/>	50-60Hz ⊕
Um <input type="text"/> kV BIL/SIL/AC <input type="text"/> kV	Ir <input type="text"/> A
C1 <input type="text"/> pF C2 <input type="text"/> pF	P.F. <input type="text"/> % AT 10kV/20° C
<input type="text"/> kg	<input type="text"/>

Fig. 2

The month is indicated by a code, as follows:

A = January	L = July
B = February	M = August
C = March	P = September
D = April	R = October
E = May	S = November
H = June	T = December

#### 2. MOUNTING INSTRUCTIONS

##### 2.1 ACCEPTANCE

Upon receipt of the goods the Customer should operate as follows:

Check the external surfaces of the packing cases:

- No sign of damage shall be found
- The shock-watch indicator, placed in the external part of each packing case (fig. 3), must be white.



Fig. 3

If the shock-watch indicator is red, do not refuse shipment, make a notation on delivery receipt, and inspect for damage as follows:

- Open the packing case by removing its cover
- Make sure that the anchoring elements are in order and securely fixed
- Make sure that there are no breaks or broken parts. Please consider that each bushing has been tested with the tail immersed in oil, therefore some oil traces can be found.

#### CAUTION

In case any damage is found, leave the original packaging, and request an immediate inspection from carrier within 15 days of delivery. Moreover, give the forwarding agent a written claim and notify the manufacturer with the details of the packing list, including the number of the case and the serial number of the bushing, to the following address:

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## 2.2 Storage

- Concerning the storage of the bushing, the location (outdoor, rain protected or indoor) and the duration of storage (short, medium, or long term) must be considered. If necessary, a storage canister can be ordered to the manufacturer (fig. 4).

### CAUTION

In general, the moisture protection of the bushing must be mounted at any time.

	Outdoor, protected from rain	Indoor
<b>Short term</b> max.1 year	In original transportation box, covered with plastic. <u>Recommended:</u> Additional moisture protection with a second plastic bag and desiccant cartridge.	In original transportation box and original packing.
<b>Medium term</b> max. 2 years	Not recommended	In original transportation box and original packing.
<b>Long term</b>	Not recommended	<u>Upper and lower parts of the bushing in a storage canister, filled with oil or dry nitrogen (fig.4).</u> or: In original transportation box and original packing. Only in dry rooms, temperature as constant as possible. <u>The desiccant cartridge should be checked regularly. The bushing must be fully wrapped into laminated aluminium foil (fig.5) (PETP/Al/PE).</u> Quantity of desiccant 2½TME/m <sup>2</sup> for moderate climate 25 TME/m <sup>2</sup> for extreme climate TME/ m <sup>2</sup> : Desiccant unit per m <sup>2</sup> of the barrier surface

**Note: Bushings stored in special storage canisters can be used immediately even after long-term storage without any further testing.**

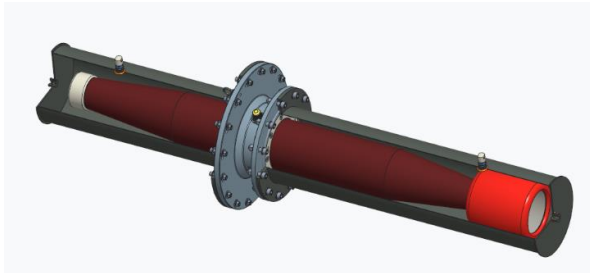


Fig. 4

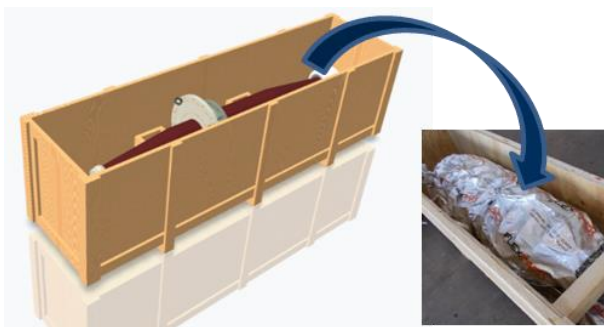


Fig. 5

**CAUTION**

Until the moment of installation on the transformer, the bushing must be considered as an equipment for indoor installation

**2.3 LIFTING AND TRANSPORTATION**

POBR bushing type is sturdy; nevertheless, to avoid dangerous movements, it is recommended to follow the suggested operations.

**Packed bushing**

The case containing the bushings can be easily lifted with a tackle by applying the ropes on the points and with a tilt as indicated in fig. 6. Some indications also appear in the packing case.



Fig. 6

**Unpacked bushing**

To take the bushing out of the case, operate as indicated in fig. 7a.

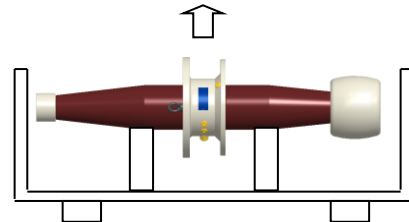


Fig. 7a

The best way to transport the unpacked bushing is keeping it in vertical position; be careful to place up the SF<sub>6</sub> side (the one starting from the larger side of the flange). To lift the bushing, it is necessary to use the holes placed on the rib between the two flanges (see fig. 7b).



Fig. 7b

**CAUTION**

This is a delicate operation. Before starting the handling, be sure that the ropes are well fixed. All these operations must be performed by AUTHORIZED PEOPLE ONLY.

**2.4 SHIPMENT TO THE END USER**

It is necessary to ensure that the quality of packing, the protection against humidity and damage, is as good as on delivery.

Silica gel cartridge, used to protect the bushing from humidity, shall be checked to verify if its performance is still good. The supplier recommends in any case to use new drying cartridges.



### Proceedings after inexpert storage

It is possible that humidity diffuses into the insulation core. If you are suspicious whether the storage conditions meet the requirements in the table above or not, you can verify it by performing a capacitance and power factor  $\tan\delta$  measurement at about 10 kV test voltage applied to the main conductor. If the power factor deviates too much from the original factory test results or if you are uncertain about the conditions, please contact the manufacturer for further information. Please mark down the prevailing temperature at the time of measurement.

### 2.5 INSTALLATION ON THE TRANSFORMER

This type of bushing can be installed on the transformer in any position: vertical or horizontal or any other.

The bottom end of the bushing is always shielded by a suitable aluminium insulated electrode. The shield has the function of increasing the dielectric strength in oil and screening the connection between the lead coming from the transformer winding and the bushing itself.

This deflector is removable to facilitate the connection between transformer cable and bushing.

- Deflector removable upwards: it can be unscrewed upwards (fig. 8).

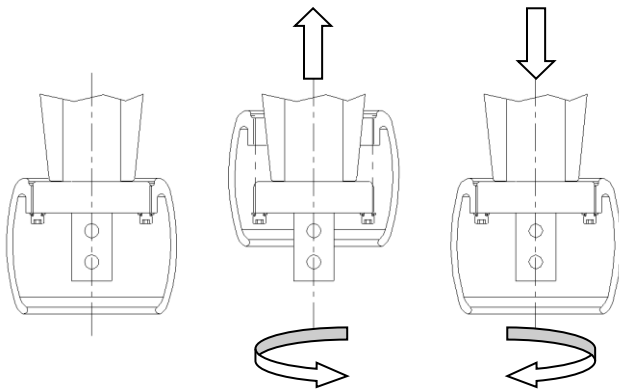


Fig. 8

- Clean carefully the bushing terminal surface with a lightly abrasive rap, in order to eliminate every trace of dirty, then clean with alcohol
- Mount the lower electrode
- Install the bushing on the transformer.

#### CAUTION

During handling, take care that no damage occurs on the external finishing coat of the deflectors, important for the dielectric strength of the bushing.

### 2.6 TEMPERATURE LIMITS

Bushings of the series POBR are designed for operation at temperatures, according to IEC 60137, table 2:

- Ambient temperature max.  $\leq + 40^{\circ}\text{C}$
- Daily average value.  $\leq + 30^{\circ}\text{C}$
- Ambient temperature min.  $\geq - 25^{\circ}\text{C}$
- Oil temperature average value.  $\leq + 90^{\circ}\text{C}$
- SF<sub>6</sub> temperature max.  $\leq + 70^{\circ}\text{C}$
- SF<sub>6</sub> pressure min. according to outline drawing

For special requirements regarding low ambient temperatures (up to  $-55^{\circ}\text{C}$ ) special O-rings are provided. For any other special or different condition please inform the manufacturer and ask the permission to put the bushings in service.

### 2.7 OIL FILLING OF TRANSFORMER

The bushing can be kept installed during vacuum treatment of the transformer. It is recommended from the manufacturer to apply vacuum to the transformer through the provided air venting plug (positioned onto the main flange) to guarantee the max. oil level.

#### CAUTION

After de-aeration, make sure the de-aeration plug is set back in place and tightened. In case of missing or loose de-aeration screw, water can enter the bushing and the transformer. High voltage  $\geq U_n/\sqrt{3}$  should be applied to the bushing not earlier than 12 hours after oil filling.

### 2.8 CONNECTION TO BUCHOLZ RELAY

A 1/4" GAS plug is placed on the bushing flange (fig. 9) in order to:

- connect the relay tube
- eliminate the air pocket which may have been formed during some executions and by filling the upper part of the transformer not under vacuum conditions. In this case we suggest unscrewing the plug and letting the air flow out. When oil starts to exit, please close it.

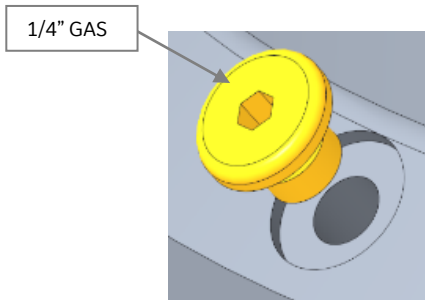


Fig. 9

## 2.9 INSTALLATION AND CONNECTION TO SF<sub>6</sub> SIDE

The annular surface of the flange is machined with a roughness degree of 1.6 µm. Beware not to damage the surface during mounting operations. Tighten with 4-8 screws the connection to the bushing SF<sub>6</sub> flange with the torque indicated in table 1, depending on the screw type. The SF<sub>6</sub> shield is supplied only for some types, so all the connection edges are to be shielded by the Customer. It is important that the connection is not rigid to avoid dangerous mechanical stresses generated by thermal material expansions.

The SF<sub>6</sub>/cable sealing is made by an O-ring gasket in "Viton" (fluorinated rubber). We recommend choosing for it a diameter not lower than 6.99 mm.

Screw type	Torque (Nm)
M8	13
M10	25
M12	40

Table 1

## 3. SERVICE AND MAINTENANCE

### 3.1 CHECKS AFTER INSTALLATION

Before putting the bushing into service, carry out a measurement of dissipation factor  $\tan\delta$  and capacity  $C_1$  between high voltage conductor and test tap at voltage up to 10kV. These measures will be used as reference for later checks.

Normally the measurement must be carried out between the HV terminal and the Power Factor tap. The capacitance & Tan Delta values are reported in the documents delivered with the bushing.

During the operation, the connection tap must always be grounded. The PF tap is schematised in fig. 10.

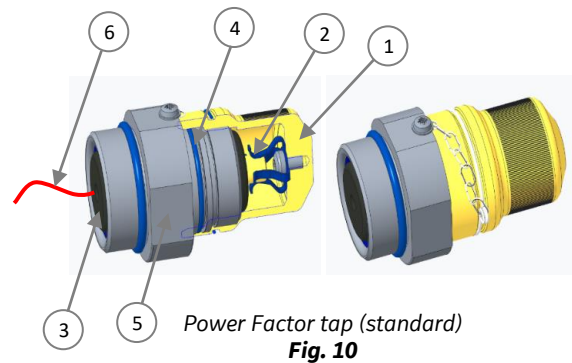


Fig. 10

1. Closing and grounding cap (removable)
2. Measurement electrode
3. Insulating bushing
4. Gaskets
5. Mounting flange
6. Last layer

### WARNING

The PF tap must be grounded during normal operation of the bushing, all the time.

Do not apply voltage to the bushing if the PF cap is removed. The cap grounds the tap connection.

It is advisable to check that the cap of the PF tap (see fig. 10) is well screwed. A forgetfulness of this generates during service a voltage on the tap that exceeds the insulation dielectric strength: this may lead to a catastrophic failure.

The obtainable measurement accuracy depends on the changes of  $C_1$  and  $C_2$  as a function of the temperature of the bushing. It can be calculated with < 5%.

### WARNING

Don't unscrew the mounting flange item 5 of fig. 10: it fixes the PF to the bushing.

If this operation accidentally the electrical contact between the internal condenser body and the flange can be damaged.

### 3.3 MAINTENANCE

POBR bushings are hermetically sealed and therefore an excellent preservation in time of the dielectric properties of resin impregnated paper is ensured.

As for the preservation of the active part, these bushings require no maintenance. It is recommended to perform the measurement of the dielectric losses ( $\tan\delta$ ) every 5 years, following the instruction under par. 5.





Check the proper location of the tap cap and its suitable complete screwing to prevent entrance of moisture.

#### Spare parts

When ordering spare parts always indicate serial number and type of bushing mentioned on the name plate.

#### Repair

Repair only accordingly to manufacturer's instructions. For this, please have serial number, type of bushing and exact description of damage ready.

#### Disposal

After reaching the end of its lifetime, this product must be disposed correctly according to local laws and regulation. All the contained substances and material should be recycled separately. The product as a whole and its individual parts do not contain any toxins. No breathing, no skin protection nor any special precautions are required. Apply the common and appropriate safety standards to prevent working accidents. In case of uncertainties please contact the manufacturer, for advanced information and instructions.

### 4. DISASSEMBLY OF THE BUSHING

To disassembly the bushing, operate according to the constructive solution adopted for the transformer, in parallel with the following suggestions:

- connect the relay tube
- Bring the oil until a level lower than the bushing flange
- Remove the top and bottom connections
- Fix the bushing like indicated in par. 2.3
- Remove the bolts that fix the flange
- Finally lift the bushing following the indication given in par. 2.3.

### 5. MEASUREMENT OF DIELECTRIC LOSSES

The Standards - IEC 60137 - state that the resin impregnated paper bushings must have a  $\tan\delta$  less than  $7 \times 10^{-3}$ .

The standard IEEE C57.19.01-2000 state that the resin impregnated paper bushing must have a  $\tan\delta$  less than  $8.5 \times 10^{-3}$ .

For manufacturer's internal rule RIP bushings pass the inner test only if a  $\tan\delta \leq 4 \times 10^{-3}$  is measured.

The measurement is performed in manufacturer's Test Laboratory by means of a Schering bridge at the voltages requested by the Standards.  
All these values are shown in the Test Report.

Measurement at the voltage of 10 kV is carried out to have a reference value for comparison with measurements made at site during the service of the bushing.

For this it is advisable to measure capacitance and  $\tan\delta$  upon the installation and use these values as base for future comparison measurements.

With the bushing already installed on the transformer and the SF<sub>6</sub>/cable terminal disconnected, the measurement can be performed by means of a bridge, by applying a voltage of 10 kV between the HV terminal and PF tap, maintaining grounded the flange (C1 measurement). The bushing is considered good if a  $\tan\delta$  less than the maximum one established by the Standards is measured. If a  $\tan\delta$  higher than the above one is measured, please contact the manufacturer, who will decide if it is necessary to make other tests before removing the bushing from service or to ship it back, to make a complete check, eventually to replace the active part with another of new manufacture.

In order to measure the Co value (capacitance between the PF tap and flange) the flange has to be supplied with a maximum voltage of 2 kV and the PF tap has to be connected to the bridge.

A field measurement of  $\tan\delta$  and capacitance can differ from the measurements carried out in the factory due to the different conditions of test and relevant accuracy: for this reason, a light shifting (max 10% for  $\tan\delta$ ) is acceptable. Furthermore, the installation conditions can affect the capacitance value.

#### Electrical checks

Bushings are suitable for service if, as regards the values of reception test, they do not increase over (note: values are only indicative):

- 1% for the capacitance C1 (this assure that there is not a perforation between two layers)
- 30% for  $\tan\delta$  of capacitance C1.
- 100% for  $\tan\delta$  of capacitance Co.

### 6. EXTRAORDINARY CHECKS

If these checks give negative results, it is necessary to ship back the bushing to the manufacturer, who will perform a complete set of electrical tests and eventually will decide to make an oil treatment to the bushing or to replace the active part with another one of new construction.

#### Contact us

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