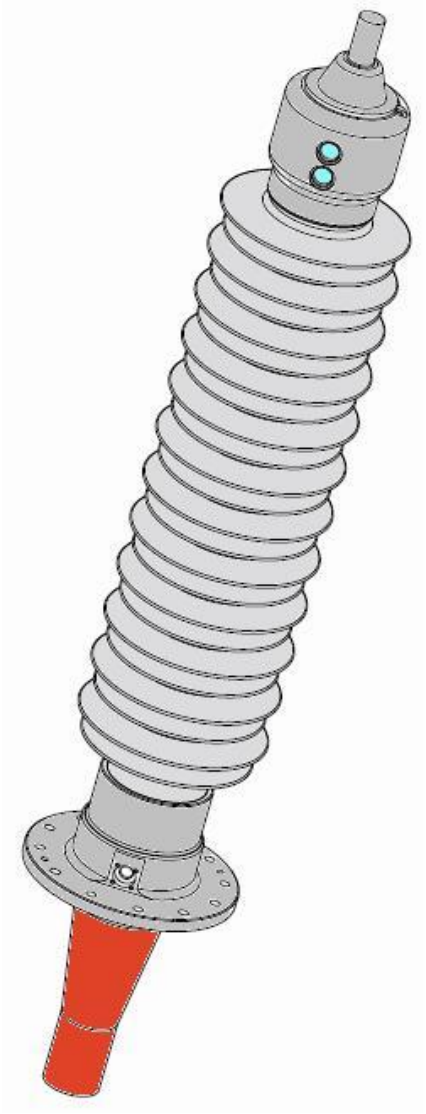
OIL TO AIR BUSHINGS SERIES PSO WITH COMPOSITE INSULATOR

VOLTAGE FROM 52 TO 170 kV



INSTRUCTION FOR STORAGE, TRANSPORTATION, INSTALLATION AND MAINTENANCE

INDEX

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1 DESCRIPTION

1.1 GENERAL

This instruction is applicable to the oil paper condenser type bushings of the series:

“PSO” with composite insulator

according to IEC 60137; it provides all general information to be followed from the receipt of bushings until their installation on the transformer.

More information is given regarding their service and maintenance.

The designation of the bushing is the following:

PSO 145. 650. 1250

P	Condenser bushings (”P” from Italian word ”Passante”)
S	Short tail type, oil to air
O	Oil paper insulation (OIP)
145	Rated voltage (in kV)
650	BIL class -Basic Insulation Level (in kV).
1250	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 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.

Please follow carefully all the instructions of the manual and pay attention to the WARNING (severe hazard), and CAUTION (minor hazard) signs.

WARNING

Please follow carefully all manual procedure and prescription given in the current manual. Any deviation means to loss immediately product guarantee.

1.3 TECHNICAL CHARACTERISTIC

These bushings are capacitance graded type with oil impregnated paper insulation, short tail, designed for use on power transformers, for installation with inclination up to 45° from the vertical.
They are provided for operation with the upper part in the open air (normally or highly polluted atmosphere) and with the lower part immersed in the transformer oil.
The schematic design is showed in fig. 1.

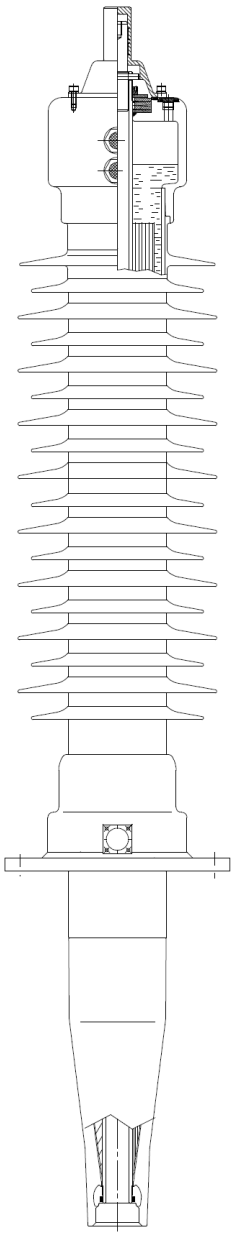

Fig. 1

1.3.1 INSULATION

The main electrical insulation is given by a condenser body, made of a continuous sheet of pure Kraft paper, wound around a tube.
Heated cylinders and infrared rays dry the paper during winding, to reduce the water content in the paper to 1% maximum.
During the winding a sequence of aluminium foils, with cylindrical shape and coaxial disposition, is inserted between the layers of paper. These foils grade the best possible distribution of the radial and longitudinal electrical gradient between the conductor and the fixing flange, which is grounded.
The winding is made by computer-controlled machines, with simultaneous machining to the final shape. After the winding the bushing is assembled and placed into an oven at 105 °C, treated under vacuum (each bushing individually), kept at $4 \cdot 10^{-2}$ mm Hg for some days and impregnated with oil (having max. humidity content of 3 ppm and suitably degassed). The impregnation is made under pressure in order to obtain the best impregnation and to test the perfect tightness.
After impregnation the head of bushing is filled with nitrogen cushion. All this process is automatic, and computer controlled.

1.3.2 AIR SIDE

The air side envelope is made of grey hollow composite insulator (glass-reinforced epoxy tube covered with silicone sheds) with metal fittings glued at both edges. This insulator has a high mechanical resistance and guarantees bushing top tightness.
Composite material used is compliant with international standards IEC 62217, IEC 60507 and IEC 60695-11-10.

1.3.3 OIL SIDE

The lower end of the bushing is of short type; its length is reduced to a minimum, compatibly with the permissible longitudinal voltage gradient. The oil side envelope is made of moulded epoxy resin. This type of housing has been employed by PASSONI & VILLA for the first time in 1963, for the manufacturing of the transformer side envelope in the re-entrant type bushing.
The epoxy resin is bi-components type, i.e., consists of a resin base and a hardener, the charge material is quartz sand. The epoxy resin envelopes have shapes, thickness, and dimension tolerance not possible to be achieved by porcelains, moreover they can grant the possibility of making metal parts embedded in the mass itself.
Transformer oil shall contain less water than 10ppm and dielectric rigidity bigger than 60kV, measured according with IEC156.

1.3.4 HEAD AND OIL LEVEL INDICATOR

Bushing head is made of aluminum alloy casting. It is bushing oil compensator which contains bushing oil volume variation. Oil level control is done through an oil level inspection glass (Fig. 2).

Fig. 2 – Prysmatic oil level indicators

1.3.5 Top Terminal

The HV terminal is removable and is coupled to the copper lug or the draw rod by means of Multi-blades contact and it is fixed on the head by means of four screws.
Terminal is made of aluminium without any surface treatment; upon request it can be silver-plated.

1.3.6 FLANGE

The flange is made of aluminium casting, equipped with the following accessories:

- Lifting holes.
- Power factor tap (tested at 2 kV for 60 s), for the measurement of the dielectric characteristics.
- Buchholz relay connection (½" GAS plug for air outlet from the transformer).
- Voltage tap upon request (tested at 20 kV for 60 s);
- Oil sampling plug (for 145 and 170 kV bushings);
- Oil sampling valve (for 245 kV bushings).

1.3.7 TYPE OF DIELECTRIC

The impregnation is made with a top quality inhibited super grade mineral oil, fully complying to Standards IEC 60296 and ASTM D3487, with the following outstanding characteristics:

- High dielectric strength (>70 kV/2,5mm);
- Very good low temperature properties (pour point typically <-60°C);
- Low viscosity even at the lowest temperatures.
- Very good oxidation stability.
- Extremely good heat transfer.

1.3.8 GASKETS

Made of Fluorocarbon elastomer, O-ring type. They are compatible with impregnating oil of bushing and hot mineral oil of the transformer.
Flat gaskets are fitted concentrically to o-rings, to prevent a direct contact from the metal parts and the porcelain envelope.
For special requirements regarding low ambient temperatures (up to -60°C) special o-rings are foreseen, made of nitrile mixtures.

1.3.9 NAME PLATE

Each bushing is provided of a name plate, with serial number and all the electrical data, in accordance with the prescription of IEC Standards.
The plate (fig. 2) is made of aluminium and is fixed on the flange by nails. 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
13 - Weight
(*) Only for bushings with Um < 100 kV

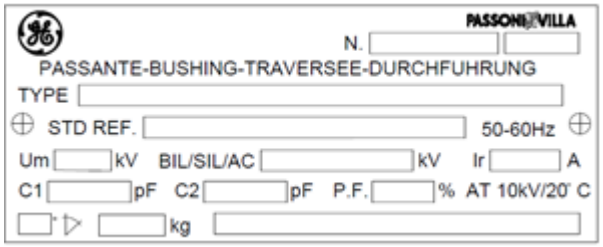

Fig. 3

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 PACKAGING AND STORAGE

2.1 PACKING

After test, just before packaging, bushing is cleaned to remove oil from bushing lower part and possible dust from top insulator. Bushing in the case is leaned slightly, being AWARE that bushing DOES NOT LAY ON hollow insulator silicone sheds (Fig.4).

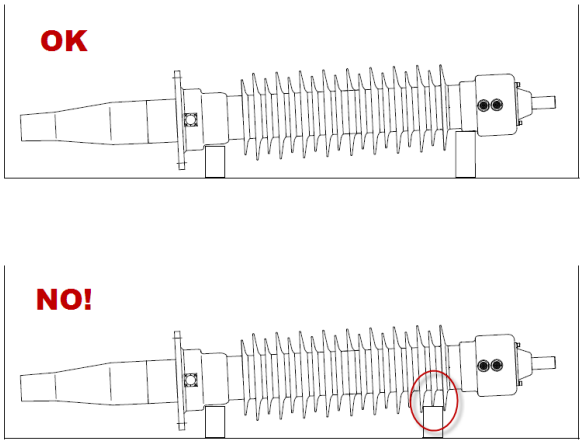

Fig. 4

2.2 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 and tilt indicators, placed in the external part of each packing case (fig. 5 and 5A), must be white (NOT ACTIVATED).

If the shock or tilt indicator is red (ACTIVATED) don't refuse shipment, make a notation on delivery receipt and inspect for damage as follow:

Fig. 5

- 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 leaks from the bushings, especially in the joints between parts and 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.

In case any damage is found, leave in original packaging and request an immediate inspection from carrier within 7-15 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:

GRID SOLUTIONS SpA – Unit RPV.
Via Mario Villa, 210
20099 Sesto San Giovanni (ITALY)
Phone: +39-02-24105001

2.3 STORAGE

Every bushing is protected with a polyethylene bag hermetically sealed and containing a Silica-gel bag; in such a way the bushing is protected in dry air against the humidity of the ambient.
Although there are no preclusions for the bushings remaining in the open air, it is hardy recommended to store them in a closed room.
The bushings must be kept in their original packing.

For a long time storage (greater than one year) or open air storage, the bushings lower part shall be protected by a canister, a rigid container, hermetic and containing Silica-gel salt, or by a metallic container, oil filled and hermetic. Bushings protected in this way can be stored for a long time even in the most unfavourable weather conditions.

⚠ AVVERTENZA

Before bushing installation on transformer, and as well during all storage period, be aware that lower bushing part, under flange, shall be protected against external humidity.
Till bushing will not be installed on transformer, it must be considered as an indoor machine.

Limit storage temperatures goes from -25 to +50 °C.

3 LIFTING AND TRANSPORTATION

The bushing type PSO is sturdy, nevertheless, in order to avoid dangerous movements, it is better to follow the suggested options.

3.1. PACKED BUSHING

The case containing the bushings can be easily lifted with a tackle by applying the ropes on the points and with the inclination as indicated in fig.6.

Some indications appear also in the packing case.

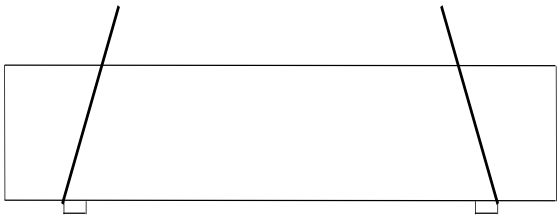

Fig. 6

3.2. UNPACKED BUSHING

To take the bushing out of the case, operate as indicated in Fig. 7 to Fig. 8.

Considering bushing weight and dimensions, we suggest using two similar lifting tools.

The best way to transport bushing is in vertical position; use a lifting rope to fix the head at the bottom side. See fig. 8a.

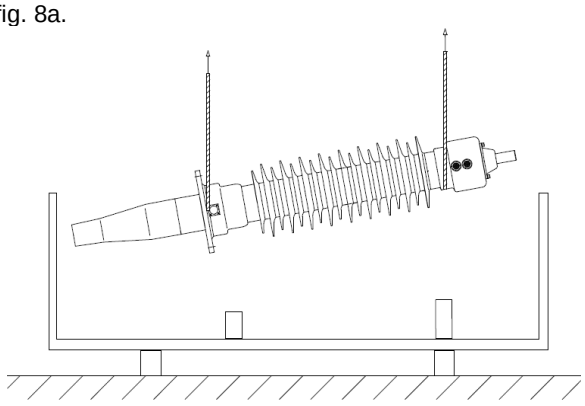

Fig .7

Lifting rope must be fixed under metal head and the beginning of hollow insulator, but never crushing silicone sheds.
On the flange of bushings two holes M12 are foreseen. They can be used for the connection to earth, or if necessary, to apply two eyebolts for lifting, or to tighten two screws working as extractors during the dismount from transformer, in case of difficulties.
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⚠ WARNING

Lifting bushing is a delicate operation. Before starting be sure that lifting ropes are well fixed. This operation shall be done just by qualified and professional staff.

3.3. INCLINED MOUNTING

If the bushing must be mounted in inclined position, it will be necessary to apply the rope as in Fig. 8b.

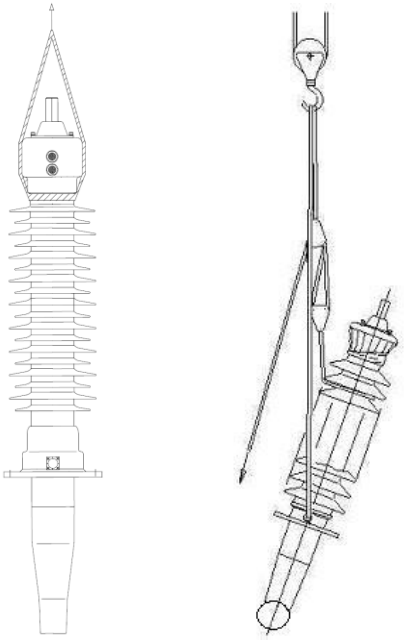

Fig. 8a *Fig 8b*

WARNING

During all bushing handling, COMPLETELY AVOID putting bushing head under bushing tale level. Otherwise, nitrogen will migrate from bushing head to bottom bushing side.

3.4. SHIPMENT TO FINAL CUSTOMER

Packing of bushing after test at transformer factory, to be shipped to the final destination, shall be done using the same original packing, or, if no more available, in an equivalent one.
In particular, the bushing tail shall be protected against moisture through a plastic seal with dehydrating medium (silicagel)
The status of the dehydrating medium shall be periodically checked and in case dried in oven.

4. INSTALLATION IN THE TRANSFORMER

5. TEMPERATURE LIMITS

The bushings of the PSO series are designed to work at the maximum temperatures established by the IEC 60137 regulations:

Ambient temp.:	Maximum: + 40°C
	Minimum - 25°C
Oil temperatures:	Maximum: +100°C
	Max. temp. medium: + 90°C

For special applications it is possible to supply a product capable of working even at minimum temperatures of –60°C.
The permitted overtemperatures are established by the IEC 60137 standard.

6. SERVICE AND MAINTENANCE

6.1. CHECKS AFTER INSTALLATION

Following installation on the transformer, it is advisable to check the capacitance and tanδ values of the bushing.
Normally the capacitance measurement (C1) is carried out between the upper terminal and the capacitive socket or PF socket (fig. 15).

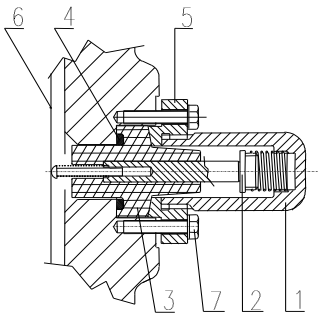

Fig. 15

1 – closing and grounding cap (removable)
2 – measurement pin
3 - insulator
4 - gasket
5 – mounting flange
6 – outermost aluminum foil
7 – fixing screws (non-removable)

During the measurement, the PF tap must always be earthed, either by keeping the cap screwed on or via the measuring instrument.
The capacitance values measured during the FAT (Factory Acceptance Tests) are reported in the bushing's test report

WARNING

BEFORE ENERGIZING THE BUSHING, ALWAYS CHECK THAT THE CAP OF THE PF SOCKET (Pos.1) HAS BEEN REFITTED AND TIGHTENED ADEQUATELY (tightening torque 2 Nm).

6.2. BUSHING DISMANTLING

To disassemble the bushing, operate according to the transformer manufacturer's instructions, always keeping the following requirements in mind:

- Bring the transformer oil to a level lower than the bushing flange.
- Remove the upper terminal (fig. 11). For this operation it is necessary to dismantle the terminal by pulling it upwards and at the same time rotating it slightly in both directions.
- Fix an eyebolt in the M12 hole of the cable lug provided for this purpose, secure a cord and remove the fixing pin.

- Harness the bushing as indicated in par. 3.
- Remove the bolts that secure the pass-through and lift it according to the instructions provided previously (Paragraph 3).

6.3. MAINTENANCE

The PSO series bushings are hermetically sealed to ensure the preservation of the dielectric properties and oil-impregnated paper insulation over time.
The internal parts of these bushings do not require any maintenance.
It is recommended every 5 years to carry out a measurement of the dielectric losses (tgδ) following the instructions as explained in par. 6.5.

Oil Level

Periodically check the bushing oil level and top it up if necessary. Filling can be carried out through the hole located in the upper part of the head, near the terminal (fig. 11), using carefully treated and degassed transformer mineral oil. Close the filling hole with the appropriate cap (tightening torque approximately 100 Nm).
Filling the head of the bushing with the nitrogen or dry air cushion is advisable but not strictly necessary.

⚠ WARNING

To prevent oxidation of the oil in the bushing and the entry of humidity, close the filling hole immediately after topping up.

6.4. MEASUREMENT OF ELECTRICAL LOSSES

Test with the bushing installed on the transformer
With the bushing already installed on the transformer and the upper terminal not connected to the line, the measurement can be carried out with a bridge, applying a voltage of 10 kV between the upper terminal and the PF tap, keeping the flange to earth (C1 measurement). The bushing is considered good if the tgδ is lower than the maximum value established by the reference standards.
If the tgδ value is higher than that prescribed by the Standards, contact the manufacturer to decide whether to carry out other tests before removing the bushing or sending it back to the factory for checks and possible repairs, if possible.
To measure the value of the capacitance Co (capacitance between the PF tap and the flange) the flange must be placed at a maximum voltage of 2 kV and the PF socket must be connected to the measuring bridge.
A field measurement of the capacitance and tgδ values may differ from the measurements carried out at the manufacturer due to the different test conditions and the precision of the instrumentation: for this reason, a maximum deviation of 10% for the tgδ value is still acceptable. Furthermore, due to the installation conditions, stray capacitances appear which can influence the capacitance measurement.

For this reason it is recommended to carry out the capacitance and tgδ measurements as soon as the bushing is installed on the transformer and keep these values as reference values for subsequent measurements.

6.5. CHECKS ON OLD BUSHINGS

Before installing an old bushing, it is necessary to carry out airtightness tests and routine electrical tests.

Electrical Tests

The old bushings are suitable to be put back into service if the values found by the electrical tests have not increased compared to the values measured with the new bushing (indicative values) of:

- 10% for C1 capacity (this ensures that there is no perforation between two condenser foils).
- 50% for the tgδ od C1 capacitance.
- 100% for the tgδ od Co capacitance.

An increase in the last value means a worsening of the dielectric characteristics of the external layers of the capacitor body and/or of the oil present in the gap between the capacitor body and the external insulator.

6.6. EXTRAORDINARY CHECKS

If the electrical tests show a tgδ value higher than the limits, it is suggested to take an oil sample and carry out the following tests:

- Humidity content
  Initial value: ≤ 10 ppm
  Value in operation: ≤ 20 ppm

- Rigidità Dielettrica
  Initial value: ≥ 62 kV/2,5 mm
  Value in operation: ≥ 45 kV/2,5 mm

- Perdite Dielettriche (tgδ)
  Initial value: $\leq 7*10^{-3}$
  Value in operation: $\leq 12*10^{-3}$

- Gas-chromatography (DGA)
  Refer to Standards IEC 60599 e IEC TR 61464

If these checks give negative results, it is necessary to send the bushing back to the manufacturer for the necessary checks and repairs (if possible).

6.7. OIL SAMPLING

The operation involves a total withdrawal of approximately 0.2-0.3 liters of oil from the bushing.
The oil taken must be replaced by adding the same quantity of transformer oil, carefully treated and free of dissolved gases, which is perfectly miscible with the bushing oil. Filling must be carried out using the filling cap placed on the head of the bushing (fig. 11), which must be hermetically closed as soon as the operation is completed.

⚠ WARNING

The operation MUST BE CARRIED OUT with the bushing out of voltage, properly grounded

WARNING

The oil sampling must be carried out as quickly as possible and on a day with low humidity, so as not to contaminate the oil present inside the bushing

7 DISPOSAL AT THE END OF LIFETIME

The bushing consists of the following material:

Component	Material	Action
Winding conductor	Copper or aluminium alloy	Dismount and recycle
Terminals and bottom plates	Copper, aluminium alloy or brass; optional silver or tin coating	Dismount and recycle
Insulating oil	Mineral oil acc. IEC60296	Recycle
Winding	Cellulose paper and thin aluminium foils	Dispose or thermo-destruction
Nuts, bolts, washers and springs	Stainless steel, carbon steel	Dismount and recycle
Top oil expansion vessel	Borosilicate glass	Dismount and recycle
Flange and extension	Aluminium alloy	Dismount and recycle
PF tap and cover	Nickel or tin coated brass, tin coated copper	Dismount and recycle
Top insulator	Composite insulator made of glass fibre reinforced epoxy. Silicone	Dispose or thermo-destruction
Insulator fittings	Aluminium alloy	Dismount and recycle
Bottom insulator	Either porcelain acc. IEC60672 or epoxy resin	Dispose or thermo-destruction
Bottom shield	Aluminium alloy covered with either epoxy paint or epoxy resin	Dismount and recycle