

# PSO

## Short-Tailed Type Condenser Bushing Oil-to-Air - Oil-Impregnated Paper - 52 to 170 kV

PSO bushings are capacitance-graded short-tailed bushings with an oil impregnated paper core. They meet IEC 60137 Standards for insulated bushings for alternating voltages above 1000 V.

They are designed for use in power transformers and can be installed up to a 45° maximum inclination off vertical. Design, components and manufacturing technology promote an average lifetime in excess of 30 years under normal operating conditions.

### Voltage and Current Ratings

Rated voltage range for PSO bushings is:

- 52 to 170 kV, for normal cantilever load
- 52 to 170 kV, for heavy cantilever load.

Standard rated currents are 800 and 1250 A.

There are two alternative conductor connections:

- Draw lead connection for:
  - 800 A with any under flange length for CT accommodation
  - 1250 A with no under flange length for CT accommodation
- Draw rod connection for 1250 A, with any under flange length for CT accommodation. Minimum draw lead conductor sections are listed in fig.13.

\* Catalogue UNDER revision  
Drawing for specific projects are sent according to applicable IEC std.



### Standards

- IEC 60137

### Key Benefits

- Bushings with longer lifetime and higher reliability
- Possibility to use bushings under extreme weather condition (lower pour-point value)
- No performance reduction with age
- Oil level visible from any side



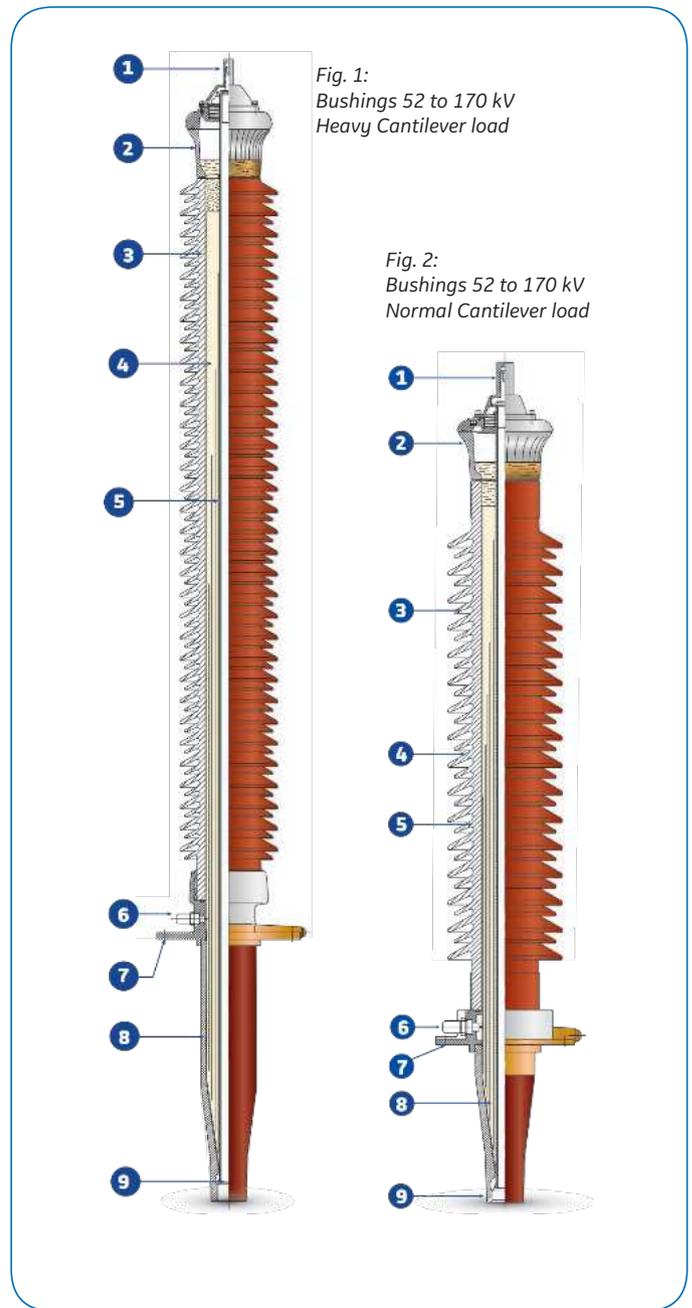
## PNO Bushings Main Features

### Standards Condenser Bushings with short oil side length oil-to-air transformer application

- Range from 52 to 170 kV
- Current up to 1250 A
- Oil-Impregnated Paper
- Air side: porcelain insulator or composite insulator
- Oil side: epoxy resin insulator
- Partial discharge: max. 5 pC at 1.5 U<sub>m</sub>/√3
- Provided with power factor tap
- Draw lead for 800 and 1250 A  
draw rod for 1250 A application
- Head made of special UHV filter prismatic glass with oil level indication visible at any angle of sight
- Flange made of cast aluminum alloy
- Standard angle of installation max of 45° off vertical

**Fig. 1: Bushings 52 to 170 kV Heavy Cantilever load**  
**Fig. 2: Bushings 52 to 170 kV Normal Cantilever Load**

1. HV Terminal
2. UHV filter glass
3. Porcelain
4. OIP Condenser
5. Winding tube
6. Power factor tap or voltage tap
7. Flange
8. Epoxy resin insulator
9. Embedded shield



## Bushing Designation

### PSO.145.650.800.X

PSO	IEC type Condenser Bushings, short tailed series, Oil-Impregnated Paper (OIP) oil-to-air application
145	Insulation class in kV
650	BIL in kV
800	Rated current in A
X	Cantilever load: N = Normal H = Heavy

## Manufacturing

The main electrical component is the condenser body, manufactured using a continuous sheet of pure kraft paper, wound around a central conductor tube or rod. During the winding process, the paper is dried by heated cylinders in order to reduce its water content to 1% maximum. A series of aluminum foils are coaxially inserted between the layers of the paper, to achieve the best possible distribution of the radial and longitudinal electrical gradients between the central tube and the flange, which is grounded. The condenser core is made by computer-controlled winding machines, with subsequent machining to achieve the final shape. After winding, each bushing is individually assembled and placed into an oven and processed under vacuum for the appropriate period of time. Each bushing is then impregnated with synthetic oil, which has been degassed and processed so that it has a maximum water content of 3 ppm. Each bushing is placed under pressure to insure thorough impregnation and to test that it is properly sealed. After impregnation, the bushing is head filled with a nitrogen cushion. This process is an automatic and computer controlled process.

## Top Terminal

Standard bushing top terminal is made of aluminum without any surface treatment. Upon request, it can be supplied in tinned or silvered copper. This terminal is connected to the copper inner terminal lug or the draw rod by means of multi-blade contacts and is secured to the bushing head by screws.

## Head and Oil Level Indication

The metal components of the head are made of a cast aluminum alloy. Bushings have an oil head reservoir, prismatic in shape, made of borosilicate glass, and containing a UHV filter. This allows for an easy check of the oil level even from a distance and at any angle of sight.

## Air Side

The air side insulator is made of brown porcelain. Grey porcelain or composite insulator (resin fiberglass envelop covered by silicone sheds) is available upon request.

The typical creepage distance is suitable for very heavy polluted atmospheres.

The shed configuration is an alternating type: short-long shed. This is the most effective solution, proven by salt spray tests. The shed profile complies with IEC 60895 recommendations. A one-piece porcelain is used for bushings.

## Flange

The flange is made of cast aluminum, and is equipped with the following accessories:

- Lifting holes
- Power factor tap, tested at 2 kV for 60 s (fig. 3)
- Buchholz relay connection: 1/2" gas outlet plug
- Oil sampling plug (for  $\geq 145$  kV bushings).

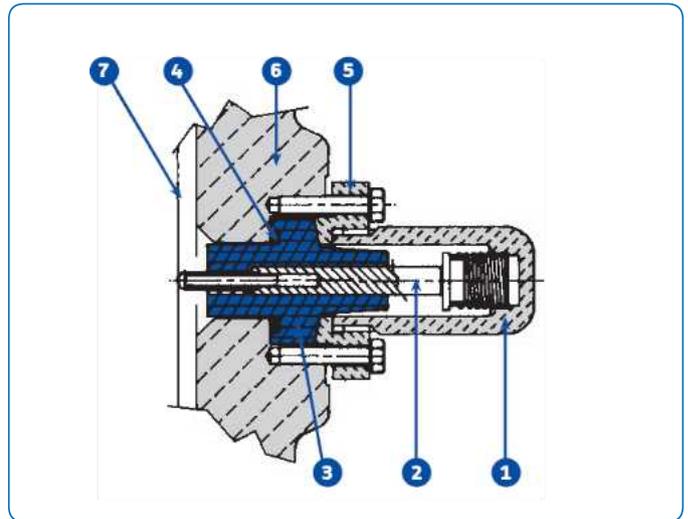


Fig. 3: Power Factor Tap

### Fig. 3: Power Factor Tap

1. Closing and grounding cap
2. Measurement electrode
3. Insulation tap
4. gasket
5. Tap flange
6. Bushing flange
7. Last layer

## Oil Side

The Bushing oil side lower end is a short-type: its length is reduced to the minimum, compatibly with the permissible longitudinal voltage gradient. The oil side envelope is made of molded epoxy resin. This resin is a two-part compound consisting of a resin base and a hardener; the filler material is quartz sand. The epoxy resin envelope permits shapes, thickness and dimensional tolerances not possible with porcelain. Under flange sleeve length for CT accommodation, different from standard, is available upon request. In this case, the grounded part is obtained by means of a metallic tube or directly by the last metallic layer inside the condenser body.

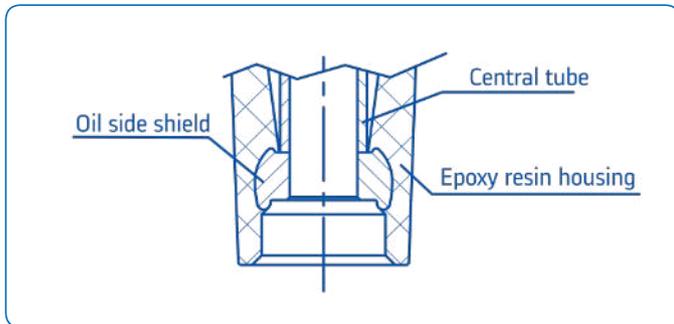


Fig. 4: Oil side shield embedded in the epoxy resin housing

## Oil Side Shield

The bottom end of the bushing is shielded by a proper deflector, made of aluminum alloy. It is designed in order to reduce the electric field stress in oil and to screen the connection between the lead coming from the transformer winding and the bushing itself.

## Assembling

The mechanical coupling among all the parts of the bushing is made by means of springs placed in the head bushing. Bushings for heavy cantilever ("H") loads are always assembled using (air side) porcelain cemented to flange (fig. 4). The cement used is quick setting monocalcic-aluminized type. All cemented surfaces, potentially in contact with the external environment, are silicone sealed (fig. 5).

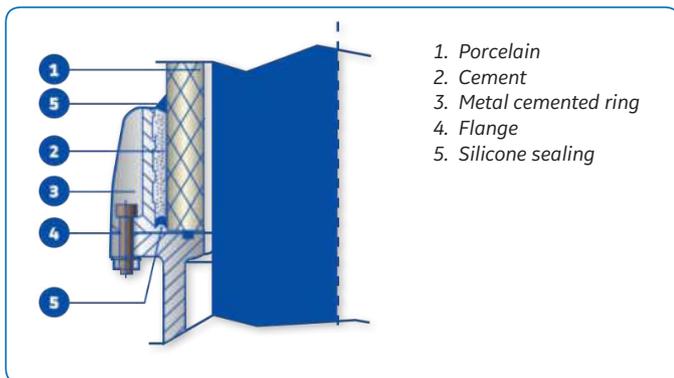


Fig. 5: Cemented porcelain

## Insulating Fluid

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 / 2.5 mm)
- 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

## Gaskets

Made of Viton®, a fluorocarbon rubber elastomer (FPM), o-ring type. They are compatible with all the fluids they are in contact with (bushing impregnating synthetic oil and transformer mineral oil). Air side gaskets are carefully protected, by means of a sealing, against influence of polluting weather elements.

For special requirements, such as low ambient temperatures (down to -55°C), special o-rings are used.



## Arcing Horns

Adjustable arcing horns are available upon request. The upper arcing horn is fixed by means of one screw used to secure the top terminal, while the bottom one is fixed on a proper threaded flange hole (fig. 6).

The suggested distances between arcing horns for given rated voltages are listed in the main table.

## Transformer Oil

The oil must have a water content less than 15 ppm for voltage up to 145 kV and less than 10 ppm for 170 kV and above rated voltage. Its dielectric strength must be higher than 60 kV, according to IEC 60156.

## Tests

All bushings have electrical characteristics and are tested in compliance with the latest edition of IEC 60137 Standards: insulated bushing for alternating voltages above 1000 V and main national Standards.

## Type Tests

- Measurement of dielectric dissipation factor ( $\tan \delta$ ), capacitance and partial discharge quantity before and after the series of type tests
- Wet power-frequency voltage withstand test
- Full-wave lightning impulse withstand voltage test
- Temperature rise test
- Verification of thermal short-time current withstand
- Cantilever load withstand test
- Tightness test
- Verification of dimensions

## Routine Tests

- Dielectric dissipation factor ( $\tan \delta$ ), capacitance and partial discharge quantity measurement
- Dry lightning impulse voltage withstand test (BIL), when prescribed
- Dry power-frequency voltage withstand test
- Measurement of partial discharge quantity
- Test of tap insulation
- Tightness test
- Tightness test at the flange
- Visual inspection and dimensional check

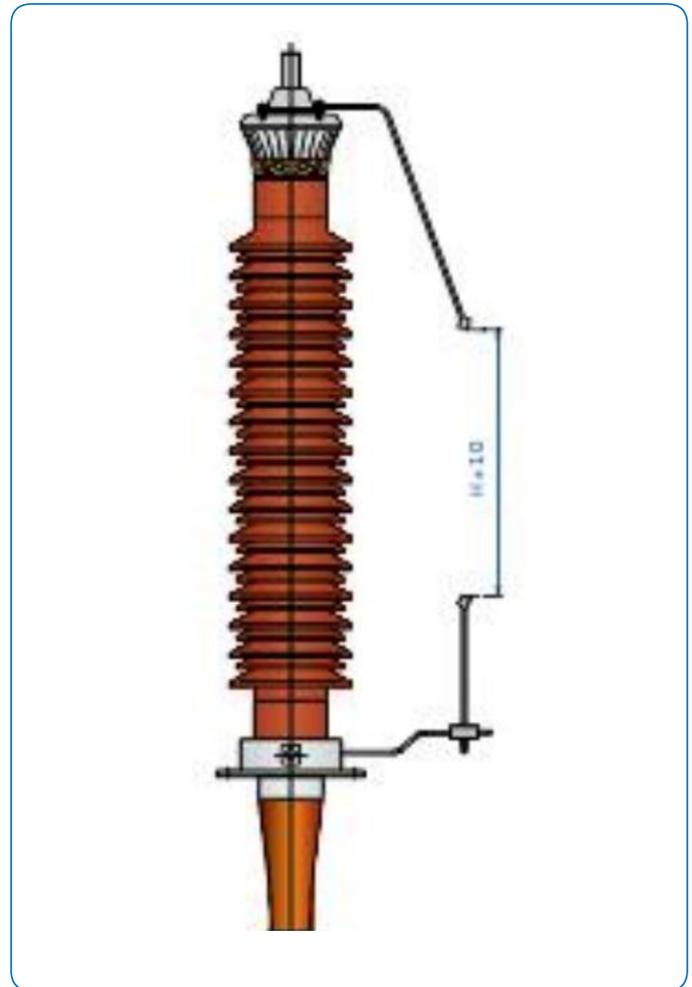


Fig. 6: Discharge distance for abushing equipped with arcing horns

## Packing - Transportation

After tests and before packing, the bushing is cleaned of any oil and or dust. Thanks to a special device to prevent the diffusion of the nitrogen cushion out of the head and into the lower end of the bushings, each bushing can be packed and shipped secured in horizontal position. This insures minimal crate dimensions and reduced transportation costs. Proper protection is used for oil side shields. Bushings up to and including 170 kV are normally shipped in crates containing three pieces.

## PSO Range from 52 to 170 kV: Ratings / Dimensions

Type	Nominal System Voltage	Rated line-to-earth voltage	BIL	Rated current	Dry power frequency withstand voltage (for 60s)	Flexible draw lead connection	Rigid draw rod connection	K min. (CT pocket)	Creepage distance (for Normal/heavy cantilever load)	C: Arcing distance (for Normal/heavy cantilever load)	Normal cantilever load	Heavy cantilever load	Weight	Max. operating altitude	H (discharge distance) +/-10%
	kV	kV	kV	A	kV			mm	mm	mm	N	N	kg	m	mm
52.250.	800	52	30	250	800	X	...	0	1722/1662	610/550	1000	1600	21	4000	320
	1250				1250		95				X*		X		
72.5.325.	800	72.5	42	325	800	X	...	0	2359/2299	760/700	1000	2000	27	3000	450
	1250				1250		140				X*		X		
100.450.	800	100	58	450	800	X	...	0	3100/3040	985/925	1000	2000	41	2000	600
	1250				1250		185				X*		X		
123.550	800	123	71	550	800	X	...	0	3886/3806	1155/1075	1250	3150	70	3000	750
	1250				1250		230				X*		X		
145.650.	800	145	84	650	800	X	...	0	4539/4459	1405/1325	1250	3150	99	2000	900
	1250				1250		275				X*		X		
170.750.	800	170	98	750	800	X	...	0	5333/5253	1595/1515	1250	4000	116	2000	1000
	1250				1250		325				X*		X		

(\* ) possible only for K minimum - Note: for not listed ratings, contact a representative.

Type	D1	D2	D3	D4	D5	D6	D7	R7	D10	D11	D13	L2	L3	L4	L5	L6	L7	L8	L9	t1	N.	F	
	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	N.	mm	
52.250	800	100	185	225	40	170	35	100	100	35	85	...	860	695	80	150	705	...	...	...	14	6	16
	1250											32						10	100				
72.5.325.	800	100	185	225	40	170	35	100	120	35	85	...	1010	845	80	185	855	...	...	...	14	6	16
	1250											32						10	100				
100.450.	800	115	250	290	40	170	35	115	140	35	85	...	1245	1080	80	230	1090	...	...	...	16	8	16
	1250											32						10	100				
123.550	800	115	250	290	40	230	35	115	160	35	85	...	1410	1240	80	310	1255	...	...	...	16	8	16
	1250											32						10	100				
145.650.	800	145	290	335	40	230	35	145	185	60	88	...	1660	1490	80	335	1505	...	25	...	19	12	16
	1250											32						34	100				
170.750.	800	145	290	335	40	230	35	145	225	60	88	...	1850	1680	80	405	1695	...	25	...	19	12	16
	1250											32						34	100				

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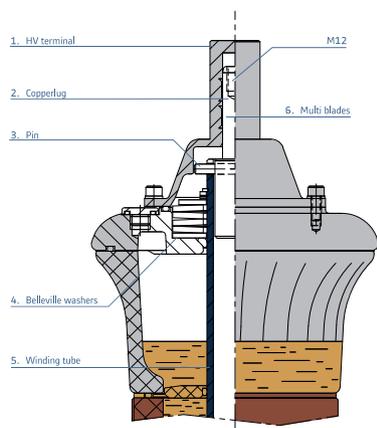


Fig. 7:  
52-170 kV bushing head: draw lead connection

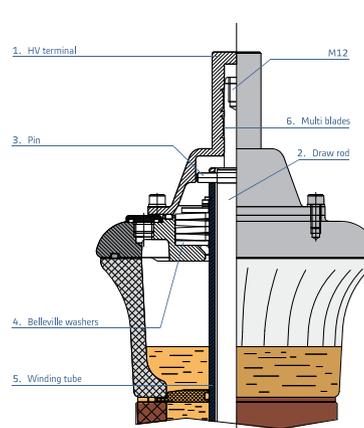


Fig. 8:  
52-170 kV bushing head: draw rod connection

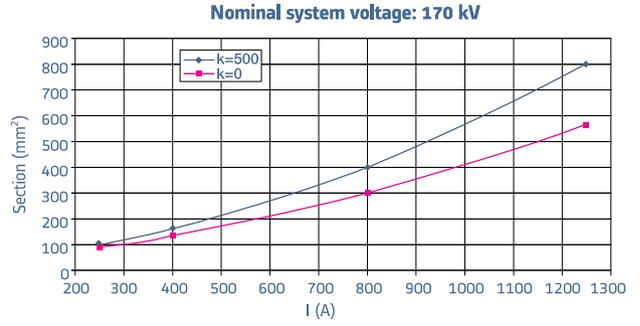
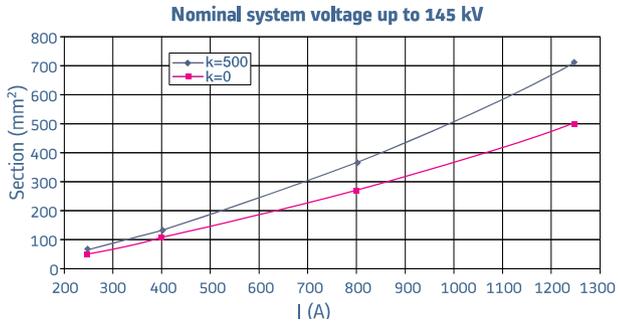


Fig. 9:  
Draw lead conductor sections

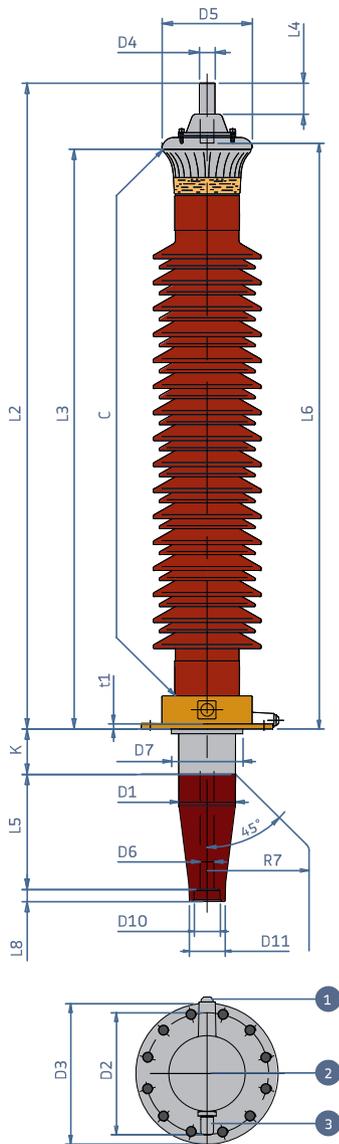


Fig. 10:  
PSO Bushings 52 to 170 kV

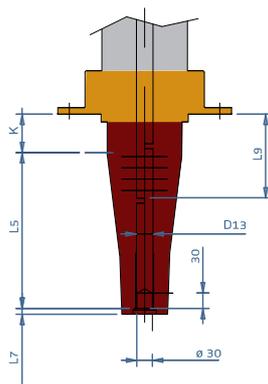


Fig. 11:  
52-123 kV bushing tail:  
draw rod connection

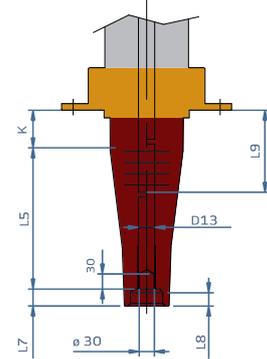


Fig. 12:  
145-170 kV 1250 A bushing tail:  
draw rod connection

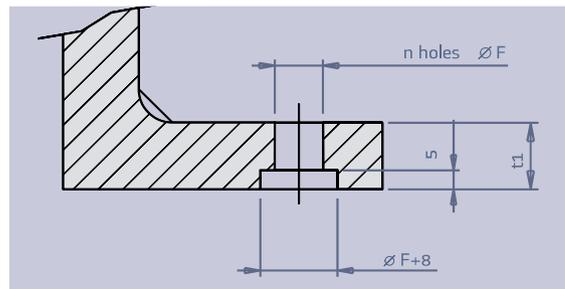


Fig. 13: Flange fixing holes

## Nameplate

Each bushing is provided with a nameplate, containing complete electrical data and the serial number, in accordance with the requirements of IEC Standards.

The aluminum nameplate, is secured to the flange with rivets and includes the following information (fig. 14):

Name plate detail

<b>PASSON</b>	<b>VILLA</b>	MILAN ITALY	SERIAL NR.	<input type="text"/>
PASSANTE-BUSHING-TRAVERSEE-DURCHFUEHRUNG				
TYPE <input type="text"/>				
<input type="radio"/>	STD REF.	<input type="text"/>	50-60Hz	<input type="radio"/>
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="checkbox"/>	<input type="text"/>	kg	<input type="text"/>	<input type="text"/>

Fig. 14: Identification Nameplate

For more information please contact  
GE  
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### Worldwide Contact Center

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Imagination at work