

PNR COMPOSITE

Condenser Bushing 24 kV-550 kV Oil-to-Air Applications Resin Impregnated Paper Bushing

PNR Bushings are capacitance graded bushings with Resin Impregnated Paper core. Design, Components and manufacturing technology of RIP Bushings promote an average lifetime in excess of 30 years under normal operating conditions.

GE Vernova Bushings – your Partner of choice

GE Vernova, a company you can trust to harness your power. Following the acquisition of Passoni and Villa in 2008, former Alstom Grid now GE Vernova Grid Solutions offers a wide range of condenser bushings for AC and DC applications. Our partner acknowledges us as one of the most reputable and reliable Bushing manufacturers in the world.

A Wealth of Benefits

- We have pioneered in Bushing Technology with our combined experience and expertise over nine decades.
- RIP Bushings offer multiple benefits over conventional Bushings (OIP).
- RIP Bushings suitable for all transformers types are available.

Flexibility

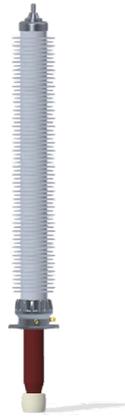
Ease of transport, handling, storage and installation. Flexibility in angle of installation.

Seismic Solutions

RIP Bushings have been seismic tested in accordance to IEC 61463 and IEEE 693-2018 for specific variants. Details on request.

Bushings to suit specific requirements

- Bushings in accordance to IEEE C57.19.01 with special flag dimensions available on request.
- Bushings in accordance to NF C52-062 including special power factor tap , flags available on request.
- Bushings for replacement with adaptation and interchangeability available on request. Specific terminals, lugs and counter flange can be provided.



Key Benefits

- Compact, Robust and Reliable design.
- Partial discharge-free up to rated nominal voltage
- Excellent mechanical strength
- High thermal strength (Class E, 120°C)
- Low dielectric losses ($\tan\delta \leq 0.4\%$)
- Suitable for Ester Oil immersion media.
- Suitable for low temperature of -50DegC

Safety – Our priority

- Personnel, Substation and Environment protection
- RIP bushings are fire and explosion-proof
- Oil and SF6 free means no environmental costs on end-of-life disposal
- Free from leakage issues
- Special Internal Arc test on Bushing
- Tracking and Erosion test on insulator

Minimal Maintenance

- RIP Bushings are 100% oil and pressure-free, hence no specific maintenance or on-site verification are required.
- Measurement of tan and capacitance is recommended as part of maintenance check

Test Standards

- Bushings conform to IEC-60137
- Bushings conforming to IEEE C57.19.01 / NF C52-062 standard are also available.
- Very High Cantilever Solution available on request.
- Tailor made Design available on request.



PNR Bushings Main Features

Resin Impregnated Paper Bushing

- Oil-to-air
- Resin Impregnated Paper
- Installation in any position
- Dimensions of flange terminals in accordance with IEC 60137 standards
- Partial discharges < 5pC at 1.5 Um/V3
- Power factor tap grounded through the cap
- Flange made of corrosion-free aluminum
- Execution with fixed and solid conductor

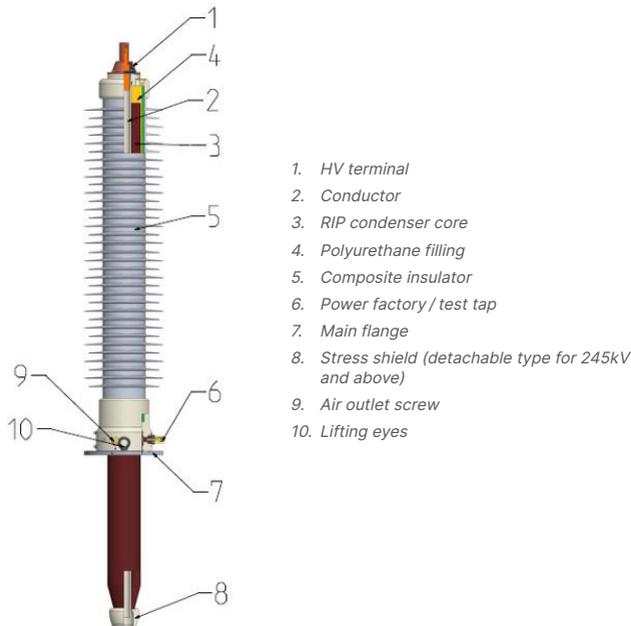


Fig. 4: PNR Bushing Typical Cross Section

Bushing Designation PNR.145.650.1250

CODE	DESCRIPTION
P	Condenser bushings ('P' from the Italian word 'Passante')
N	Normal
R	Resin Impregnated Paper (RIP)
145	Rated voltage in kV
650	BIL in kV
1250	Rated current in A

Nameplate

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

The aluminum nameplate is secured to the flange with rivets and carries the following information.

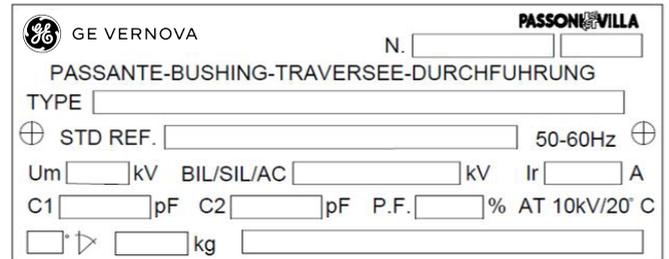


Fig. 5: Nameplate

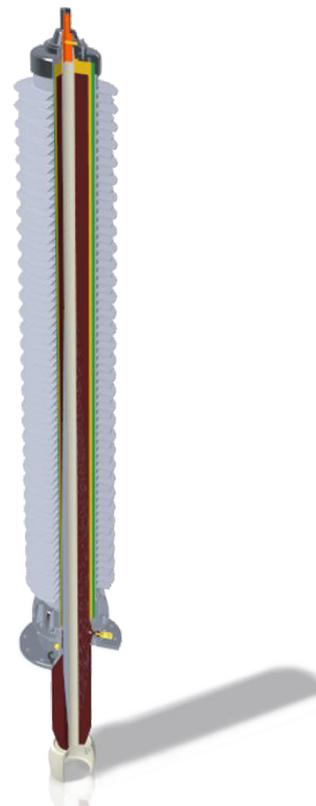


Fig.6 : Bushing section

Key Features

RIP Condenser Core

The main insulation of the bushing comprises of resin Impregnated paper. The condenser core is manufactured with crepe paper wound on central tube or rod. Winding is done under heat on a state of art winding machine. Series of Aluminum foils are inserted between the paper layers at predetermined positions to achieve the optimum distribution of radial and longitudinal electrical gradients between central tube and flange. The condenser core is then processed under heat, vacuum and resin impregnated under highly controlled conditions.

Air side insulator

The air side insulator is of composite or porcelain insulator. The composite insulator is reinforced with fiber glass tube to providing additional layer of protection, high mechanical strength and seismic performance.

Flange

The flange is made of corrosion free aluminum and is equipped with lifting holes , air vent screw and a power factor tap (tested at 3 kV for 60 s). Special coating up to CH5 class on request. Voltage tap can be provided on request.

Polyurethane Filling

The space between RIP core and the housing is dry- filled with polyurethane. Dry filling eliminates the risk of pollution (as in SF6 filling) and is leak proof should any damage exceptionally occur. Polyurethane has been specially selected for its high mechanical and electrical properties. High compressibility polyurethane makes the bushings more resistant to mechanical stress caused by thermal variation.

Assembling

The RIP condenser core and main flange are assembled in high controlled environment to avoid moisture and contamination of the RIP surface during the production.

Power Factor Tap

The PF tap is the connection to outer conducting layer of a capacitance-graded bushing. It is accessible from outside the bushing, insulated from the flange or other fixing devices, and measures the dissipation factor, capacitance and partial discharge while the bushing flange is earthed. A suitable fully mounted PF measuring tap is supplied with all RIP bushings.

Top Terminal

Bushings top terminal is made of aluminum or copper terminals. Tinned or silver-plated copper terminal can be supplied on request. Draw-lead or draw-rod type bushings (rated current up to 1600A) have a removable top terminal. This terminal is connected to the copper inner terminal lug or the draw rod by means of multi-contact and is screwed to the bushing head. In bottom-connected bushings, the inner non- removable rod extends as top terminal.



Fig. 7/8: Lifting of the Bushings



Fig. 9: Air outlet screw



Fig. 10: Voltage tap (On request)



Fig. 11/12: Power factor tap



Fig. 13: Removable top terminal



Fig. 14: Top terminal conductor

Key Features

Metal Surface Treatment

All metal bushing surfaces are made of aluminum alloy with high resistance in industrial environment, with high humidity content and aggressive atmosphere, like offshore with high salinity.

Power factor tap and voltage tap surface finish avoids any corrosion throughout lifetime and allows for easy fixing and unscrewing in service. Further finishing or final painting are the customer's option.

Electrical test

The bushings are tested according to latest edition of IEC 60137 – "Insulated bushings for alternating voltage above 1000 V". Upon request it is possible to carry-out electrical test according to other relevant standards.

Mechanical test

The SF6 side and metal parts are tested in accordance with the most stringent international standards to ensure a proper resistance to gas pressure. The flange is designed to support the mechanical stress due to the double connection, GIS from one side and transformer on the other side. The design is made in compliance with IEC 62271-211 standards. Furthermore, the bushings successfully passed tests on shaking table to ensure a proper strength to earthquakes and short circuits.

Packing & Transportation

Bushings are thoroughly cleaned after testing before packing. Bushings are packed in vacuum sealed bag along with silica gel to avoid moisture ingress. For long term storage (for spares bushings) oil side is inserted in a metallic container and sealed with Nitrogen or Oil.

Oil Side shield

The oil end is provided with a carefully designed shield to reduce the electric field stress in transformer oil. The shield is epoxy painted. The shield is integrated part of the bushing up to 170kV. Bushings rated 245kV and above are detachable type of shield. Special type of coating available on request.

Long Term Storage Accessories

For long term storage and upon request the bushings are equipped with protective tank filled with nitrogen to protect the condenser core against any damage, moisture and humidity. The crate can be equipped with shock indicator as well.

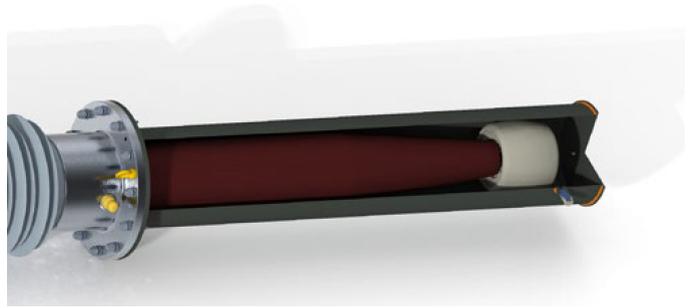


Fig. 16: Long term storage RIP bushings

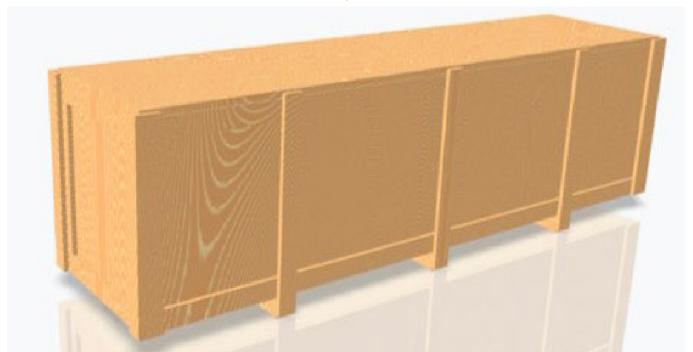
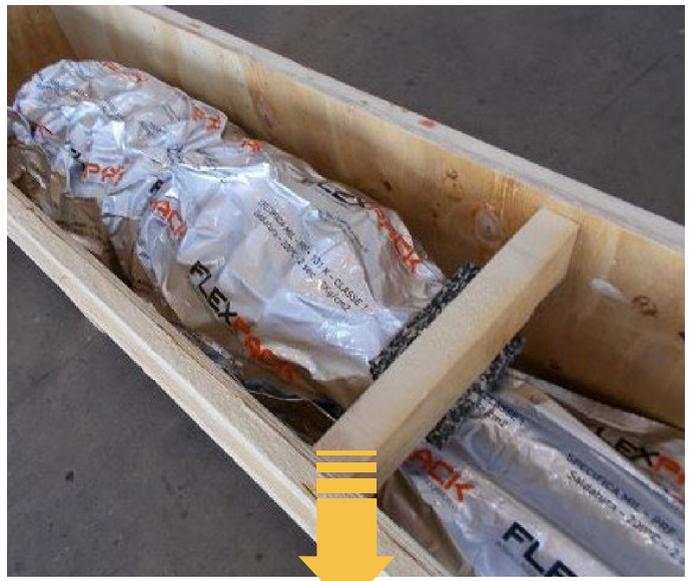


Fig. 17: Packaging - transportation



Fig. 15: Cantilever Test

PNR Range from 24 kV to 550 kV: Ratings/Dimensions

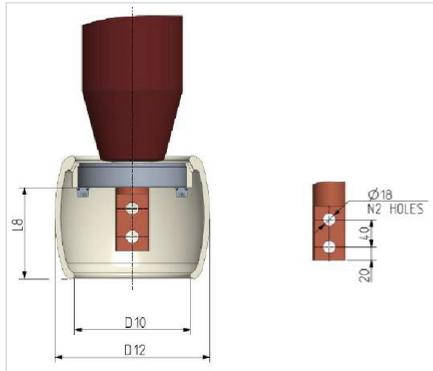
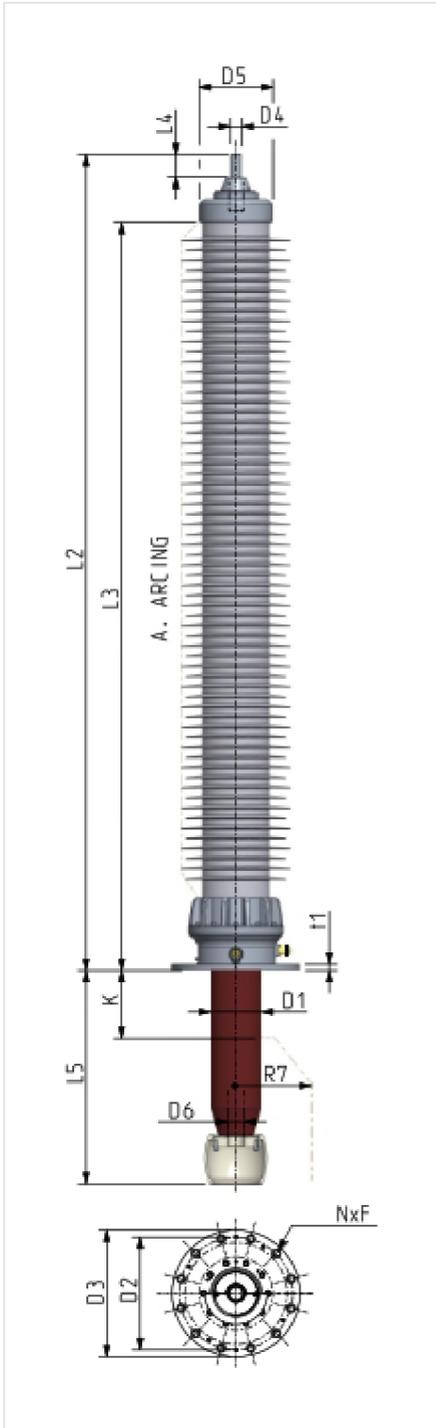


Fig. 1

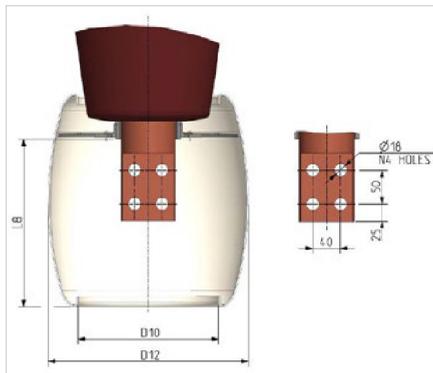


Fig. 2

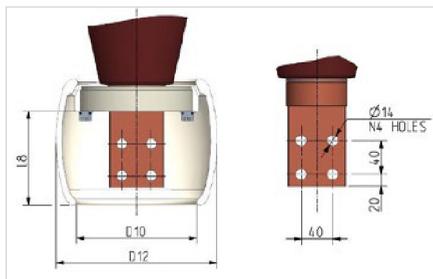


Fig. 3 Transformer side



Draw-rod connections

PNR Bushing 24 kV to 550 kV With Composite Insulator

CONDENSER BUSHING, OIL - AIR, FOR TRANSFORMERS		NOMINAL SYSTEM VOLTAGE	RATED LINE TO EARTH VOLTAGE	DRY LIGHTNING IMPULSE (BIL)	RATED CONTINUOUS CURRENT	POWER FREQUENCY WITHSTAND VOLTAGE (FOR 60S) DRY/WET	WET SWITCHING IMPULSE WITHSTAND	DRAW LEAD CONNECTION	DRAW ROD CONNECTION	BOTTOM CONNECTION	MINIMUM NOMINAL CREEPAGE DISTANCE	MINIMUM ARCING DISTANCE	CANTILEVER WITHSTAND LOAD 1MIN	MAX OPERATING ALTITUDE	SHORT TIME RATING FOR 2S (AS PER IEC 60137)	SHORT TIME RATING FOR 1S/9S
TYPE/Voltage[kV]/Current Range [A]		kV	kV	kVp	A	kV	kV				mm	mm	N	Meter	kA	kA
24.125	1000	24	14	125	1000	55/50	-	x			800	250	1250	1000	25	35/20
	1600							x		40					57/33	
	2000								x	50					71/41	
	3150								x	78,75					111/64	
36.170	1000	36	20	170	1000	77/70	-	x			1700	450	2000	3300	25	35/20
	2000							x		50					71/41	
	2500							x		62,5					88/51	
	3150							x		78,75					111/64	
52.250	1000	52	30	250	1000	105/95	-	x			1700	450	2500	1000	25	35/20
	2000							x		50					71/41	
	2500							x		62,5					88/51	
	3150							x		78,75					111/64	
72,5.325	1000	72,5	42	325	1000	155/140	-	x			2450	700	3150	1600	25	35/20
	1600							x		40					57/33	
	2000								x	50					71/41	
	2500								x	62,5					88/51	
123.550	800	123	71	550	800	255/230	-	x			3880	1035	4000	1000	20	28/16
	1600							x		40					57/33	
	2000								x	50					71/41	
	3150								x	78,75					111/64	
145.650	800	145	84	650	800	305/275	-	x			5500	1288	4000	1000	20	28/16
	1250							x		31,25					44/26	
	1600								x	40					57/33	
	2000								x	50					71/41	
170.750	800	170	98	750	800	355/325	-	x			6175	1468	4000	1000	20	28/16
	1250							x		31,25					44/26	
	1600								x	40					57/33	
	2000								x	50					71/41	
245.1050	1250	245	142	1050	1250	505/460	850	x			10100	2398	5000	1000	31,25	44/26
	1600							x		40					57/33	
	2000								x	50					71/41	
	2500								x	62,5					88/51	
300.1050	1250	300	173	1050	1250	505/460	850	x			10100	2398	4000	1000	31,25	44/26
	1600							x		40					57/33	
	2000								x	50					71/41	
	2500								x	62,5					88/51	
362.1300	1250	362	209	1300	1250	560/NA	950	x			10375	2950	5000	1600	31,25	44/26
	1600								x	40					57/33	
	2000								x	50					71/41	
	2500								x	62,5					88/51	
420.1550	1250	420	242	1550	1250	750/NA	1175	x			14447	3750	4000	1300	31,25	44/26
	1600								x	40					57/33	
	2000								x	50					71/41	
	2500								x	62,5					88/51	
550.1800	1250	550	318	1800	1250	870/NA	1300	x			18300	4645	4000	1600	31,25	44/26
	2000								x	50					71/41	

Note : For ratings not listed, please contact us.

PNR Bushing 24 kV to 550 kV dimensions with Composite Insulator

DIMENSIONS		TYPE OF CONNECTION	A	D1	D2	D3	D4	D5	D6	R7 (MIN)	D10	D12	L2	L3	L4	L5	L8	WEIGHT	T1	NO. OF HOLES	F	BOTTOM TERMINAL
TYPE/Voltage[kV]/ Current Range [A]			mm	mm	mm	mm	mm	mm	mm	mm	kg	mm	N	mm								
24.125	1000	Draw Lead	250	87	185	225	40	135	40	100	65	109	578	369	80	202	0	20	18	6	16	-
																502	300	22				
																702	500	23				
	1600	Draw Rod	250	87	185	225	40	135	40	100	65	109	578	369	80	202	0	26	18	6	16	-
																502	300	31				
																702	500	34				
	2000	Bottom Connection	250	87	185	225	40	135	NA	100	NA	NA	623	369	125	230	0	24	18	6	16	Fig. 1
																530	300	26				
																730	500	27				
	3150	Bottom Connection	250	87	185	225	60	135	NA	100	NA	NA	606	369	125	230	0	35	18	6	16	Fig. 1
																530	300	50				
																730	500	55				
36.170	1000	Draw Lead	450	87	185	225	40	135	40	100	65	109	778	569	80	217	0	22	18	6	16	-
																517	300	26				
																717	500	30				
	2000	Bottom Connection	450	87	185	225	40	135	NA	100	NA	NA	778	569	80	270	0	38	18	6	16	Fig. 1
																570	300	43				
																770	500	47				
	2500	Bottom Connection	480	119	250	290	50	177	NA	100	NA	NA	862	600	125	255	0	56	18	8	16	Fig. 1
																555	300	63				
																755	500	68				
	3150	Bottom Connection	480	119	250	290	60	177	NA	100	NA	NA	862	600	125	255	0	74	18	8	20	Fig. 3
																555	300	90				
																755	500	101				
52.250	1000	Draw Lead	450	87	185	225	40	135	40	100	65	109	778	569	80	217	0	23	18	6	16	-
																517	300	27				
																717	500	32				
	2000	Bottom Connection	450	87	185	225	40	135	NA	100	NA	NA	778	569	80	270	0	38	18	6	16	Fig. 1
																570	300	43				
																770	500	47				
	2500	Bottom Connection	480	119	250	290	50	177	NA	100	NA	NA	862	600	125	255	0	56	18	8	16	Fig. 1
																555	300	63				
																755	500	68				
	3150	Bottom Connection	480	119	250	290	60	177	NA	100	NA	NA	862	600	125	255	0	74	18	8	20	Fig. 3
																555	300	90				
																755	500	101				
72,5,325	1000	Draw Lead	700	87	185	225	40	135	40	125	65	109	1003	794	80	235	0	33	18	6	16	-
																535	300	35				
																735	500	36				
	1600	Draw Rod	700	87	185	225	40	135	40	125	65	109	1003	794	80	235	0	42	18	6	16	-
																535	300	48				
																735	500	52				
	2000	Bottom Connection	700	87	185	225	40	135	NA	140	NA	NA	1048	794	125	270	0	35	18	6	16	Fig. 1
																570	300	37				
																770	500	38				
	2500	Bottom Connection	700	119	250	290	60	177	NA	140	NA	NA	1080	818	125	275	0	90	18	8	20	Fig. 1
																575	300	106				
																775	500	116				
3150	Bottom Connection	700	119	250	290	60	177	NA	140	NA	NA	1080	818	125	275	0	90	18	8	20	Fig. 3	
															575	300	106					
															775	500	116					

PNR Bushing 24 kV to 550 kV With Composite Insulator

DIMENSIONS		TYPE OF CONNECTION	A	D1	D2	D3	D4	D5	D6	R7 (MIN)	D10	D12	L2	L3	L4	L5	L8	WEIGHT	T1	NO. OF HOLES	F	BOTTOM TERMINAL	
TYPE/Voltage[kV]/ Current Range [A]			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg	mm	N	mm		
123.550	800	Draw Lead	1035	119	250	290	40	177	NA	200	65	109	1378	1150	91	370	48	0	71	18	6	16	-
																670		300	77				
																870		500	81				
	1600	Draw Rod	1035	119	250	290	40	177	40	200	65	109	1378	1150	91	370	48	0	86	18	6	16	-
																670		300	95				
																870		500	101				
	2000	Bottom Connection	1035	119	250	290	40	177	NA	230	145	200	1378	1150	91	465	110	0	152	18	8	16	Fig. 1
																765		300	160				
																965		500	165				
	3150	Bottom Connection	1088	143	290	335	50	215	NA	230	165	220	1613	1331	125	477	130	0	192	18	12	16	Fig. 3
																777		300	197				
																977		500	192				
145.650	800	Draw Lead	1288	143	290	335	40	215	50	225	80	130	1768	1531	80	435	38	0	117	18	12	16	-
																735		300	120				
																935		500	122				
	1250	Draw Lead	1288	143	290	335	40	215	50	225	80	130	1768	1531	80	435	38	0	117	18	12	16	-
																735		300	120				
																935		500	122				
	1600	Draw Rod	1288	143	290	335	40	215	50	225	80	130	1768	1531	80	435	38	0	149	18	12	16	-
																735		300	155				
																935		500	159				
	2000	Bottom Connection	1288	143	290	335	50	215	NA	230	165	220	1813	1531	125	527	130	0	152	18	12	16	Fig. 1
																827		300	160				
																1027		500	165				
3150	Bottom Connection	1288	143	290	335	50	215	NA	230	165	220	1813	1531	125	527	130	0	205	18	12	16	Fig. 3	
															827		300	220					
															1027		500	230					
170.750	800	Draw Lead	1468	143	290	335	40	215	50	260	80	130	1948	1711	80	495	38	0	121	18	12	16	-
																795		300	130				
																995		500	136				
	1250	Draw Lead	1468	143	290	335	40	215	50	260	80	130	1948	1711	80	495	38	0	121	18	12	16	-
																795		300	130				
																995		500	136				
	1600	Draw Rod	1468	143	290	335	40	215	50	260	80	130	1948	1711	80	495	38	0	161	18	12	16	-
																795		300	175				
																995		500	185				
	2000	Bottom Connection	1468	143	290	335	50	215	NA	260	165	220	1993	1711	125	587	130	0	170	18	12	16	Fig. 1
																887		300	180				
																1087		500	185				
3150	Bottom Connection	1468	178	400	450	50	260	NA	260	165	220	2012	1725	125	587	130	0	245	22	12	23	Fig. 3	
															887		300	252					
															1087		500	256					
245.1050	1250	Draw Lead	2398	178	400	450	40	260	55	350	165	220	2897	2655	80	757	130	0	290	22	12	23	-
																1057		300	300				
																1357		600	310				
	1600	Draw Rod	2398	178	400	450	40	260	55	350	165	220	2897	2655	80	757	130	0	350	22	12	23	-
																1057		300	360				
																1357		600	370				
	2000	Bottom Connection	2398	178	400	450	50	260	NA	350	165	220	2942	2655	125	757	130	0	350	22	12	23	Fig. 1
																1057		300	360				
																1357		600	370				
	2500	Bottom Connection	2398	178	400	450	50	260	NA	350	165	220	2942	2655	125	757	130	0	350	22	12	23	Fig. 1
													2902			1207		400					
													1057			600		415					

PNR Bushing 24 kV to 550 kV With Composite Insulator

DIMENSIONS		TYPE OF CONNECTION	A	D1	D2	D3	D4	D5	D6	R7 (MIN)	D10	D12	L2	L3	L4	L5	L8	WEIGHT	T1	NO. OF HOLES	F	BOTTOM TERMINAL						
TYPE/Voltage[kV]/ Current Range [A]			mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg	mm	N	mm							
300.1050	1250	Draw Lead	2398	178	400	450	40	260	55	350	165	220	2897	2655	80	757 1357	130	300 600	300 310	22	12	23	-					
	1600	Draw Rod	2398	178	400	450	40	260	55	350	165	220	2897	2655	80	757 1357	130	300 600	360 370									
	2000	Bottom Connection	2398	178	400	450	50	260	NA	350	165	220	2942	2655	125	1057 1357	130	300 600	360 370	22	12	23	Fig. 1					
	2500	Bottom Connection	2398	178	400	450	50	260	NA	350	165	220	2902	2655	125	1057 1357	130	300 600	400 415									
362.1175	1250	Draw Lead	2950	202	400	450	40	297	60	400	110	201	3412	3112	125	758 1058 1358	124	0 300 600	415 430 445	25	12	23	-					
	1600	Bottom Connection	2950	202	400	450	50	297	NA	400	205	291	3381	3112	125	907 1207 1507	175	0 300 600	470 490 510									
	2000	Bottom Connection	2950	202	400	450	50	297	NA	400	205	291	3381	3112	125	907 1207 1507	175	0 300 600	450 500 550									
	2500	Bottom Connection	2950	202	400	450	50	297	NA	400	205	291	3381	3112	125	907 1207 1507	175	0 300 600	450 500 550	25	12	23	Fig. 1					
	420.1550	1250	Draw Lead	3750	319	450	500	40	500	65	500	166	291	4400	4060	80	1012 1312 1612	177	0 300 600					975 1000 1025	30	12	23	-
		1600	Bottom Connection	3750	319	450	500	40	500	NA	500	166	291	4400	4060	80	1017 1317 1617	190	0 300 600					1034 1077 1120				
		2000	Bottom Connection	3750	319	450	500	50	500	NA	500	166	291	4420	4060	125	1017 1317 1617	190	0 300 600	1105 1145 1185								
		2500	Bottom Connection	3750	319	450	500	60	500	NA	500	205	291	4420	4060	125	1065 1365 1665	245	0 300 600	1210 1250 1290	30	12	23	Fig. 2				
550.1800	1250	Draw Lead	4645	319	450	500	40	500	65	650	210	352	5400	5025	115	1265 1565 1865	250	0 300 600	1560 1190 1280	30					12	23	-	
	2000	Bottom Connection	4645	319	450	500	40	500	NA	650	210	352	5400	5025	115	1265 1565 1865	250	0 300 600	1310 1360 1400									



*Manufacturing Site
GE Vernova Grid Solutions
Sesto San Giovanni,
Sesto San Giovanni
Milan, Italy*

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