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CERAM INSULATORS

PP

The very Best.

That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support.

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PPC INSULATORS

Revision 1 / 2003

CERAM INSULATORS

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The very Best.

Long Rod Insulators

PPC INSULATORS

Best Performance in Engineering
Your Request is our Challenge

› ISO 9001 › IEC › DIN › ÖNORM

Index

Excellent design with extra high strength

PPC Insulators is a specialist in long rod insulators with a 60 year history of experience and development of these porcelain insulators.

We produce a comprehensive range of products for overhead transmission lines up to highest system voltages of 525 kV with the most progressive technology, engineering and in-service life.

PPC INSULATORS

Long Rod Insulators
Introduction

Long Rod Insulators
Standards

High Voltage Overhead Transmission Lines

To specify the correct porcelain long rod insulator, the following characteristics have to be defined:

- specified mechanical failing load
- minimum nominal creepage distance
- environmental conditions and grade of pollution
- type of coupling
- standard lightning impulse withstand voltage
- wet power frequency withstand voltage

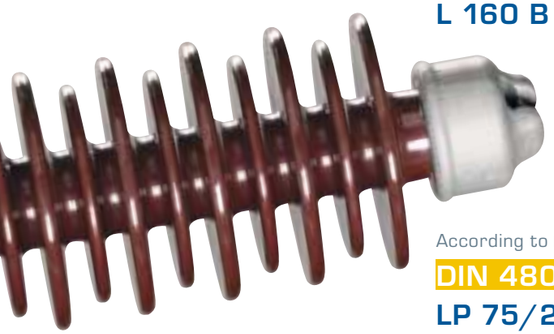
Designation

PPC Insulators manufactures long rod insulators according to IEC 60433 (1998) (including the former German standard DIN 48006 (1986)).

According to **IEC 60433** a porcelain long rod insulator is, for example, defined as follows:

L 160 B 550

L	long rod insulator
160	specified mechanical failing load (kN)
B	ball and socket coupling
C	clevis coupling (when B is replaced by C)
550	standard lightning impulse withstand voltage (kV)



According to the former German standard **DIN 48006** the same insulator was defined as:

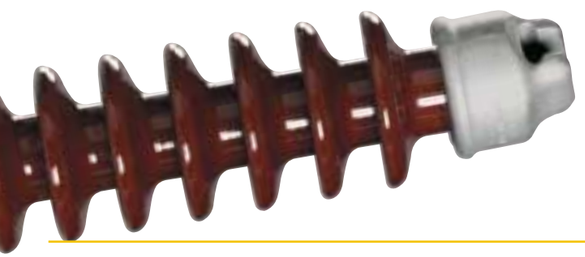
LP 75/22/1250

LP	porcelain long rod insulator with ball and socket coupling
LG	porcelain long rod insulator with clevis coupling (when LP is replaced by LG)
75	core diameter (mm)
22	number of sheds
1250	total length of the long rod insulator (mm)

According to the former Austrian standards **ÖNORM** a long rod insulator was defined as shown in the following example:

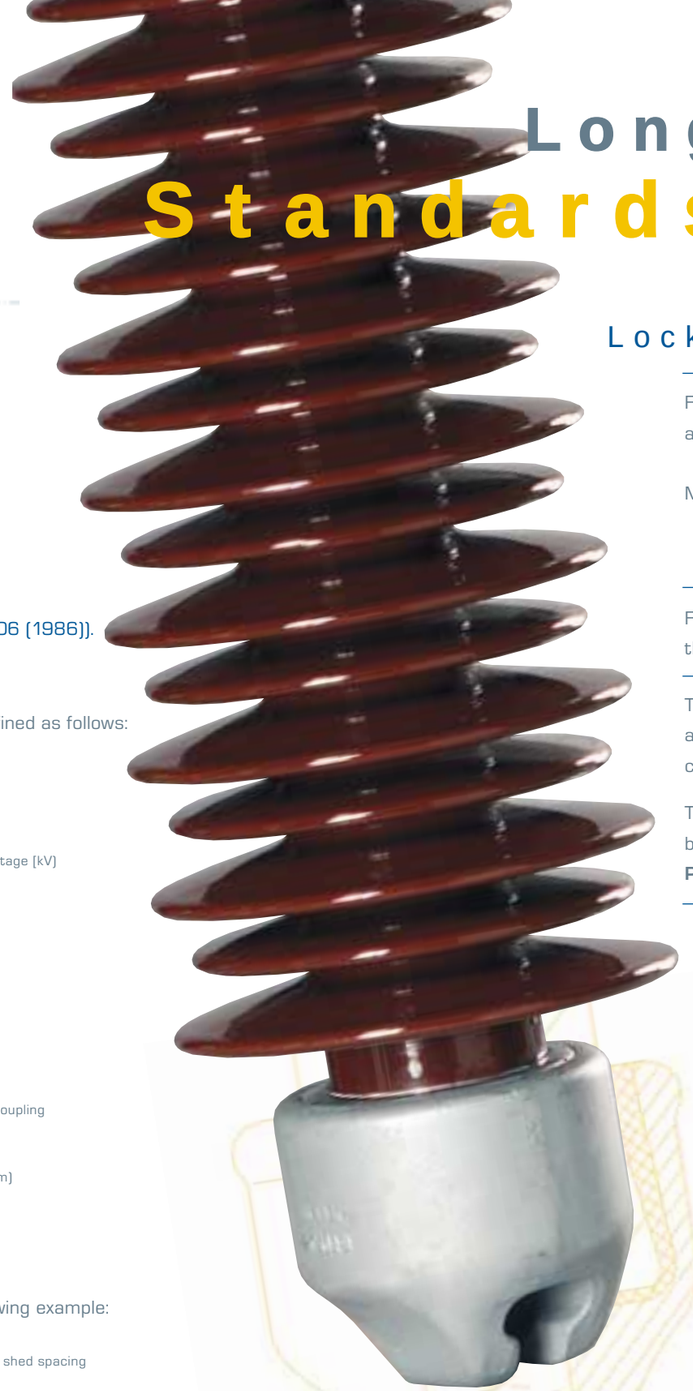
L 60/15-125

L	porcelain long rod insulator with normal shed spacing
60	core diameter (mm)
15	number of sheds
125	mechanical failing load, average value (kN)



Variations are made by changes in the initial letter as shown:

L	standard design with normal creepage distance
LH	normal creepage distance with higher strength
VL	anti-pollution type
NL	fog type
WL	with alternating sheds



Locking Devices

For **ball and socket couplings,** split pins conforming to are normally used. — **IEC 60372 (1984)**

Most of these pins also comply with — **DIN 48063 (1978) = ÖNORM E4130 (1988) ÖNORM E4131 (1988)**

For **ball and socket couplings** complying to the locking is performed by a corresponding split pin. — **ÖNORM E4104 (1988)**

The **clevis coupling** is locked by a corresponding connecting bolt with grooved nut and cotter pin according to — **DIN 48073**

These connecting bolts are not part of regular supplies, but upon customer request, **PPC** can procure these connecting bolts.

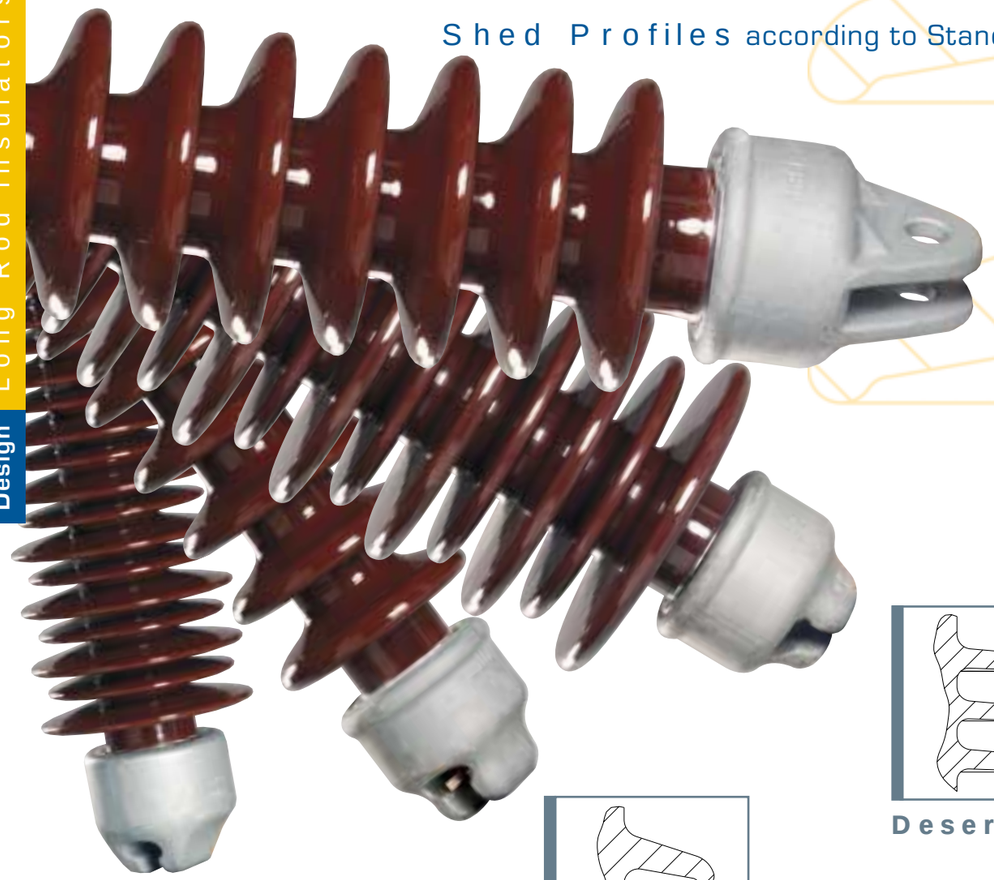
Couplings

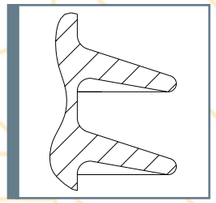
Three types of couplings for porcelain long rod insulators are available:

Ball and socket couplings conforming to
1. **IEC 60120 (1987) = DIN 48064 (1982) = ÖNORM E4125 (1988)**
2. **ÖNORM E4104 (1988)**

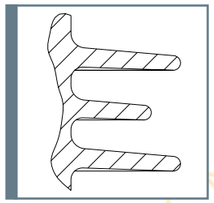
Clevis couplings conforming to — **IEC 60471 (1977) = DIN 48073 (1975) = DIN 48074 (1990) = ÖNORM E4126 (1984)**

Shed Profiles according to Standard IEC 60815

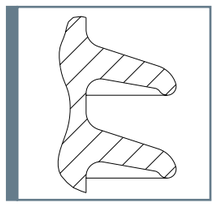




Plain shed



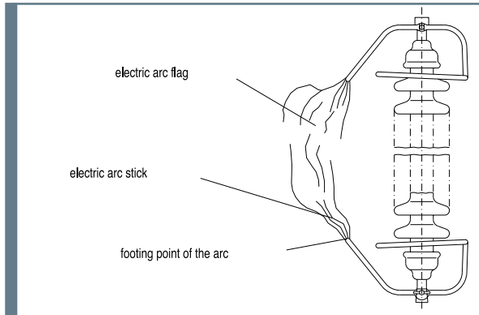
Desert shed



Alternating shed

Standard shed acc. to DIN

Electrical Values



Electric Arc Discharge along a Long Rod Insulator with Protective Fittings

The insulation performance of a long rod insulator is a function of the length, creepage and arcing distance of the insulating part and follows the standard IEC 60071 (1982-1996).

It should be noted that to provide an accurate picture of all electrical relationships, a real tower should be constructed with all relevant distances to earth in conjunction with insulators, arcing horns and protective devices.

Long Rod Insulators
Design

Creepage Distances

Porcelain long rod insulators are produced with different shed profiles to optimize performance according to environmental conditions and the grade of pollution. For example, this includes

› Fog and Salt Pollution

shed profiles for coastal areas (fog and salt pollution) which require a high protected creepage distance

› Dust Pollution

aerodynamic shed profiles for areas with desert conditions (dust pollution)

› Industrial Pollution

shed profiles for areas with heavy industrial pollution

The recommendations of standard IEC 60815 (1986) are valid for the design of the shed profiles of porcelain insulators and for the determination of the adequate tolerances.

PPC INSULATORS

Long Rod Insulators
Design

Long Rod Insulators
Production

Insulating Material

The insulator body of the unit is made from high quality aluminum oxide porcelain, C-130, which conforms to IEC 60672 (1995-1999). By customer request, we can also manufacture from aluminum oxide porcelain, C-120.

Glazing provides a dirt repellent surface. Glazing is normally brown in color; however grey can also be provided upon request.

Marking

Each porcelain long rod insulator carries the trademark of the **PPC** Insulators and of the manufacturing factory and the date of manufacture as well as the type designation and the specific mechanical failing load in accordance with standard IEC 60433.

Cementing

Cementing is provided with a lead-antimony alloy as standard although it is also possible to provide Portland cement or sulfur cement.

Insulator Cap Material (Fittings)

Insulator caps are manufactured in malleable cast iron, in minimum EN-GJMB-550-4 or EN-GJMW-450-7, according to standard DIN EN 1562 (1997). The caps are hot dip galvanized according to standard DIN EN ISO 1461 (1999) with a zinc weight of min. 600 g/m^2 (min. 85 μm) average value.

Inspection and Testing

Porcelain long rod insulators are tested according to standard IEC 60383 (1993).

Inspection and Testing of Porcelain Long Rod Insulators according to Standard IEC 60383

Test programme	Type tests	Sample tests	Routine tests
Dry lightning impulse withstand voltage test	✓		
Wet power-frequency withstand voltage test	✓		
Mechanical failing load test	✓	✓	
Thermal-mechanical performance test	✓		
Verification of the dimensions	✓	✓	
Verification of the displacements		✓	
Verification of the locking system		✓	
Temperature cycle test		✓	
Porosity test		✓	
Galvanizing test		✓	
Routine visual inspection			✓
Routine mechanical test			✓

Long Rod Insulators

Application and Advantages

underribs on sheds
not required as the core parts
between the sheds contribute
to insulation

long rod insulators can be checked ultrasonically for mechanical soundness

protection against power arcs
is achieved by the addition of
protective fittings

- cascade flashovers are not possible
- immune to thermal puncture

electrically and mechanically stressed zones are separated

routine test load = 80% of the specified mechanical failing load

minimum use of metal parts,
which minimizes corrosion problems
and also provides

- lower weight for a complete insulator set
- simpler mounting of strings
- low level of HF interference to radio and television transmissions

long rod insulators are recommended for use
in direct current applications because there is

- no pin corrosion
- no ion migration
- no problems with thermal runaway effects

minimum total life cycle costs through high reliability

long rod insulators can be used for tension
and compression loads

low surface leakage current resulting
in reduced transmission losses

puncture proof

Long rod insulators are solid core and the theoretical puncture path through the porcelain body is almost equal to the dry arcing distance. Since porcelain has several times the dielectric breakdown strength of air, flashover, if any, always occurs in the air outside the porcelain body.

self-fractures of long rod insulators made of
aluminum oxide porcelain are not known

the creepage distance is comprised of sheds and core parts which have

- good self-cleaning properties with respect to climatic conditions
- better insulation performance under pollution conditions

packaging in crates offers the maximum protection
during shipping and storage

insulator body made of aluminum oxide porcelain

- high mechanical strength
- free of internal stresses
- no measurable aging
- resistant to salt pollution
- high resistance to temperature variations
- high resistance to vandalism

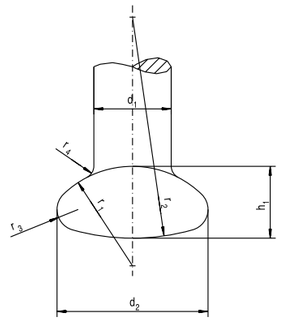
lowest maintenance costs

PPC INSULATORS

Long Rod Insulators
Ball and Socket Couplings

Standard IEC 60120

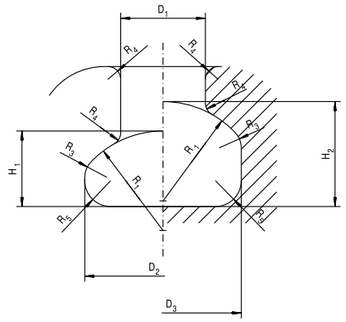
Dimensions of the Pin Ball



Designated size of coupling	d_1	d_2	h_1	r_1	r_2	r_3*	r_4
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	$11.9^{+0}_{-1.1}$	$22.8^{+0}_{-1.3}$	$9.1^{+0}_{-1.2}$	35	35	3.5	1.5^{+1}_{-0}
16	$17^{+0}_{-1.2}$	$33.3^{+0}_{-1.5}$	$13.4^{+0}_{-1.3}$	23	50	3	$3^{+1}_{-0.5}$
20	$21^{+0}_{-1.3}$	$41^{+0}_{-1.6}$	$19.5^{+0}_{-1.4}$	27	60	5.7	3.5^{+1}_{-1}
24	$25^{+0}_{-1.4}$	$49^{+0}_{-1.8}$	$21^{+0}_{-1.7}$	40	70	6.6	$4^{+1.5}_{-1}$
28	$29^{+0}_{-1.5}$	$57^{+0}_{-1.9}$	$23.5^{+0}_{-1.8}$	55	80	8	$4.5^{+1.5}_{-1}$
32	$33^{+0}_{-1.6}$	$65^{+0}_{-2.1}$	$27^{+0}_{-1.9}$	70	90	10	$5^{+1.5}_{-1}$

* given for guidance

Dimensions of the Socket End

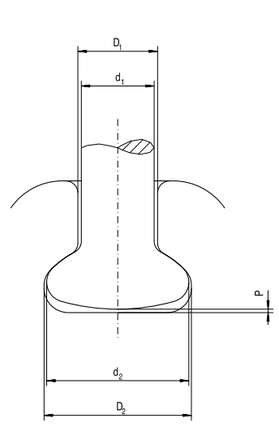


Designated size of coupling	D_1	D_2*	D_3*	H_1	H_2*	R_1	R_3	R_4	R_5	T**
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	$12.5^{+1.3}_{-0}$	24.5	24.5	$10.5^{+1.3}_{-0}$	15.5	35	4	1.5	4	4.8
16A	$19.2^{+1.6}_{-0}$	34.5	34.5	$14.5^{+1.6}_{-0}$	20.5	23	3	3	5	5.5
16B	$19.2^{+1.6}_{-0}$	34.5	34.5	$17^{+1.6}_{-0}$	25	23	3	3	5	7.9
20	$23^{+2.1}_{-0}$	42.5	42.5	$20.5^{+2.1}_{+0}$	28.5	27	6	3.5	7	7.0
24	$27^{+2.5}_{-0}$	51	51	$23.5^{+2.5}_{-0}$	33.5	40	5	4	10	8.7
28	$32^{+2.9}_{-0}$	59	59	$26^{+2.9}_{-0}$	36.5	55	8	4.5	12	10.5
32	$36^{+3.3}_{-0}$	67.5	67.5	$30^{+3.3}_{-0}$	42	70	10	5	14	11.5

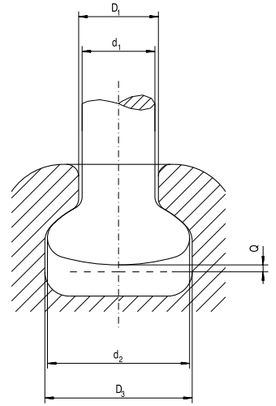
* minimal value
** minimal value of the thickness of the locking device

PPC INSULATORS

Clearance between the Pin Ball and the Socket End



The pin ball in the socket entry.



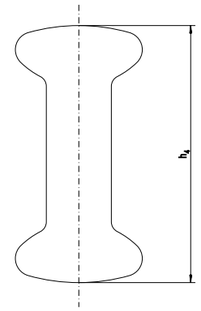
The pin ball in the socket interior.

Designated size of coupling	$D_1 - d_1$		$D_2 - d_2$	$D_3 - d_2$	P		Q*
	Min.	Max.	Min.		Min.	Max.	Min.
11	0.6	3.0	1.7	1.7	1.4	3.9	1.6
16A	2.2	5.0	1.2	1.2	1.1	4.0	1.6
16B	2.2	5.0	1.2	1.2	3.6	6.5	3.7
20	2.0	5.4	1.5	1.5	1.0	4.5	2.0
24	2.5	6.4	2.0	2.0	2.5	6.7	2.8
28	3.0	7.4	2.0	2.0	2.5	7.2	3.0
32	3.0	7.9	2.5	2.5	3.0	8.2	3.5

* clearance between the pin ball and the locking device

Dimensions of the Twin-Balled Pins

Designated size of coupling	h_4
	(mm)
11	$47^{+0}_{-2.5}$
16	$63^{+0}_{-3.0}$
20	$83^{+0}_{-3.2}$
24	$90^{+0}_{-3.5}$
28	$97^{+0}_{-3.5}$
32	$120^{+0}_{-4.0}$

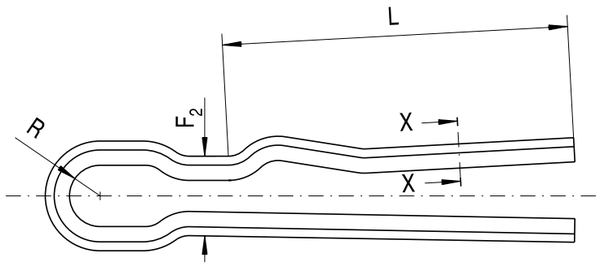


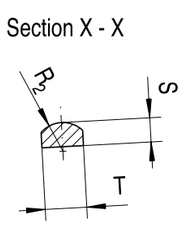
PPC INSULATORS

Long Rod Insulators
Locking Devices

Standard IEC 60372

Dimensions of the Split - Pin (V-Type) for Ball and Socket Couplings

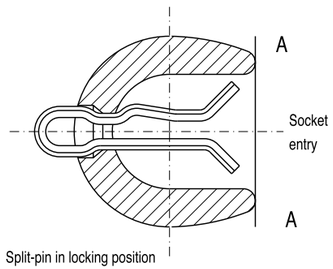




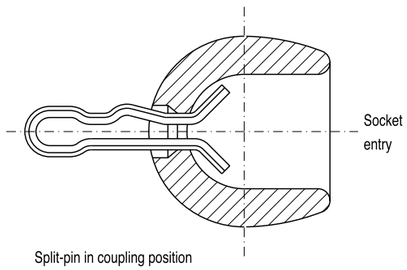
Designated size of standard coupling	Standard V-type split-pin						Alternative V-type split-pin*
	S	T	R_2	$F_{2\,min}$	R_{min}	L_{min}	$F'_{2\,max}$
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	2.2 ± 0,1	$4.8^{+0.2}_{-0}$	3.3	8.2	2.5	29	7.3
16A	3.2 ± 0.1	$5.5^{+0.2}_{-0}$	3.8	10.3	3.0	38	9.2
16B	3.2 ± 0.1	$7.9^{+0.2}_{-0}$	4.8	10.7	3.0	38	9.7
20	3.2 ± 0.1	$7.0^{+0.2}_{-0}$	4.8	10.7	3.0	49	9.7
24	4.0 ± 0.1	$8.7^{+0.2}_{-0}$	5.7	12.8	3.5	60	11.7
28	4.5 ± 0.1	$10.0^{+0.3}_{-0}$	6.2	13.8	3.5	71	12.7
32	5.2 ± 0.1	$11.5^{+0.3}_{-0}$	7.2	15.8	3.5	81	14.7

* all the dimensions are the same as for standard split-pins, except the value F_2 replaced by F'_2
The dimension L_{max} shall be specified by the purchaser of the split-pin.

V-Type Split-Pin in Locking and in Coupling Positions

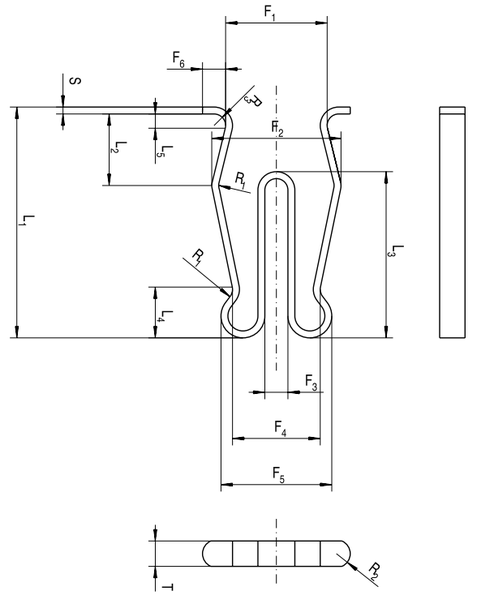


Split-pin in locking position



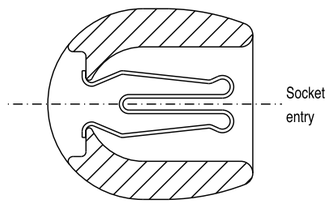
Split-pin in coupling position

Dimensions of the W-Clip for Ball and Socket Couplings

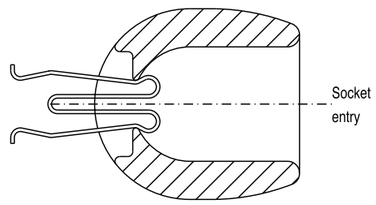


Designated size of standard coupling	F_1	F_2	F_3	F_4	F_5	F_6	L_1	L_2	L_3	L_4	L_5	R_1	R_2	$R_{3\,max}$	S	T
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
11	15	20	4	13	19	$4^{+0.6}_{-0}$	37 ± 1.5	12.0	24 ± 1.5	8.0	3	2.5	3.0	1.5	$1.2^{+0.2}_{-0}$	$4.8^{+0.2}_{-0}$
16A	22	28	5	19	24	5^{+1}_{-0}	50 ± 1.5	15.5	36 ± 1.5	10.5	3	2.5	3.0	2.5	$1.5^{+0.2}_{-0}$	$5.5^{+0.2}_{-0}$
16B	22	28	5	19	24	5^{+1}_{-0}	50 ± 1.5	15.5	36 ± 1.5	10.5	3	2.5	4.5	2.5	$1.5^{+0.2}_{-0}$	$7.9^{+0.2}_{-0}$
20	22	30	5	19	24	5^{+1}_{-0}	62 ± 1.5	15.5	42 ± 1.5	10.5	3	2.5	4.5	2.5	$2.0^{+0.2}_{-0}$	$7.0^{+0.2}_{-0}$
24	22	30	5	19	25	5^{+1}_{-0}	72 ± 1.5	15.5	50 ± 1.5	10.5	3	2.5	5.0	2.5	$2.0^{+0.2}_{-0}$	$8.7^{+0.2}_{-0}$
28	24	32	6	21	28	6^{+1}_{-0}	83 ± 1.5	16.0	62 ± 1.5	12.5	4	3.0	6.0	3.0	$2.2^{+0.2}_{-0}$	$10.0^{+0.2}_{-0}$
32	26	36	6	24	33	7^{+1}_{-0}	96 ± 1.5	18.0	71 ± 1.5	16.0	4	3.0	7.0	3.0	$2.6^{+0.2}_{-0}$	$11.5^{+0.2}_{-0}$

W-Clip in Locking and in Coupling Positions



W-clip in locking position

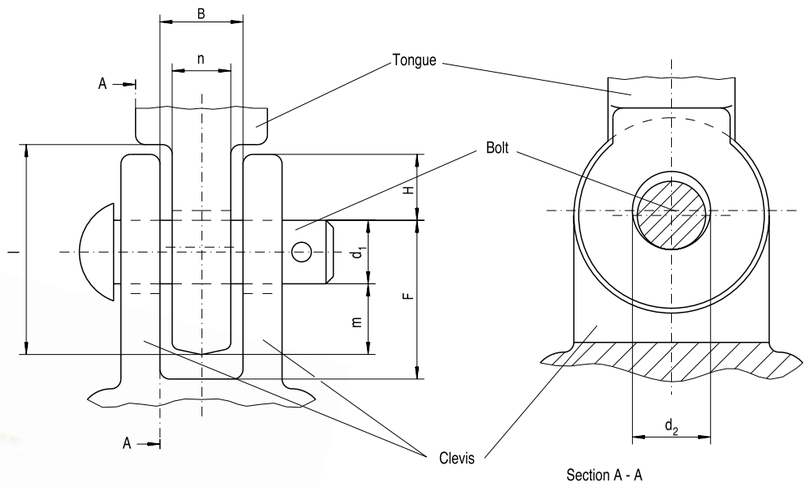


W-clip in coupling position

Long Rod Insulators
Clevis and Tongue Couplings

Standard IEC 60471

Dimensions of Clevis and Tongue Coupling

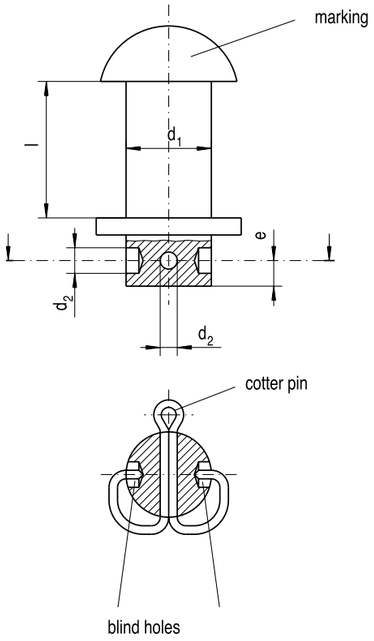


Designation		d_1	d_2	n	B	m	F	H	l
		(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
13L	Min.	12.8	14	12	14	10	32	-	45
	Nom.	13	14	13	14	13	-	-	-
	Max.	13.5	15	13.5	15.5	15	34.5	15	-
19L	Min.	18.6	19.8	17.5	20	14.5	46	-	65
	Nom.	19	20	19	20	18	-	-	-
	Max.	19.4	21.4	19.5	22	22	48.5	22	-
22L	Min.	21.8	23	17.5	20	17.5	53	-	75
	Nom.	22	24	19	20	22	-	-	-
	Max.	22.6	24.6	19.5	22	25	55.5	25	-
25L	Min.	24.2	26	23	26	18	57.5	-	80
	Nom.	25	27	24	26	23	-	-	-
	Max.	25.6	28	25.5	28	26.5	60	26.5	-
28L	Min.	27.2	29	23	26	21.5	67	-	90
	Nom.	28	30	24	26	26	-	-	-
	Max.	28.6	31	25.5	28	30	69.5	30	-
32L	Min.	31.2	33	23	26	24.5	77	-	100
	Nom.	32	34	24	26	29	-	-	-
	Max.	32.6	35	25.5	28	33	79.5	33	-

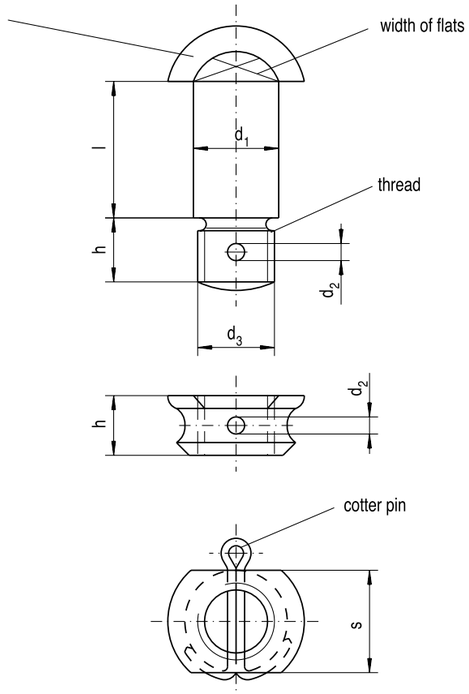
Standard DIN 48 073

Dimensions of Connecting Bolts

Shape N
with cotter pin
and disk



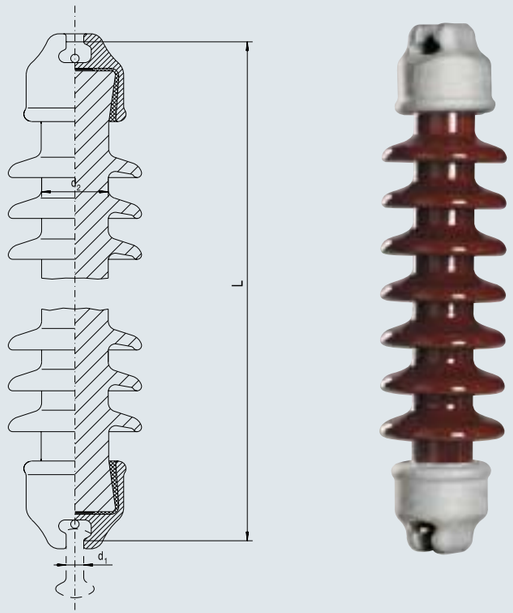
Shape S
with grooved nut
and cotter pin



Designation	d_1	l + 2*	d_2	d_3	e + 2	h ± 2	Width of flats s	Disk acc. to	Cotter pin acc. to
	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	(mm)	DIN 1441	DIN 94
N 13	$13^{+0.3}_{-0.6}$	28, 32, 40, 45	5*	-	5	-	-	15	4 x 25
S 13			5	M12	-	14	19	-	
N 19	$19^{+0.3}_{-0.6}$	34, 38, 43, 48, 52, 60, 105, 125, 145, 165, 185, 205, 225	6	-	6	-	-	21	5 x 45
S 19			5	M16 x 1.5	-	16	24	-	4 x 40
N 22	$22^{+0.5}_{-0.3}$	34, 38, 43, 48, 52, 57, 60, 66	6	-	6	-	-	23	5 x 45
S 22			5	M18 x 1.5	-	16	27	-	4 x 40
N 25	$25^{+0.3}_{-0.8}$	48, 65, 110, 130, 150, 170, 190, 210, 230, 250, 270, 290, 310, 330	6	-	6	-	-	26	5 x 50
S 25				M22 x 1.5	-	16	32	-	
N 28	$28^{+0.4}_{-0.8}$	43, 48, 52, 57, 75, 83, 215, 235, 255, 275, 295, 315, 335	6	-	8	-	-	29	5 x 50
S 28				M24 x 2	-	20	36	-	
N 32	$32^{+0.5}_{-0.8}$	43, 48, 52, 57, 83, 215, 235, 255, 275, 295, 315, 335	6	-	8	-	-	33	5 x 71
S 32				M27 x 2	-	20	41	-	

* Section of the length depending on outside distance of clevis

Long Rod Insulators
with Ball and Socket Couplings

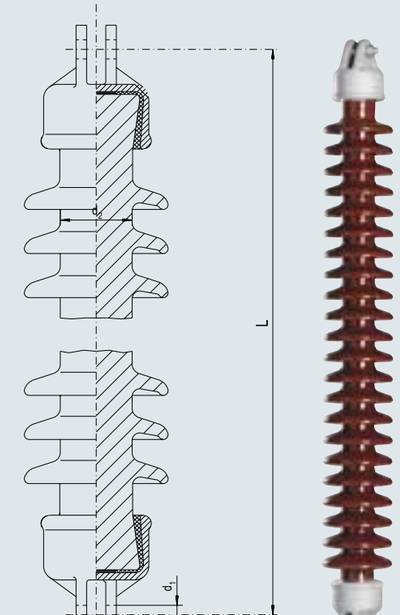


Characteristics of Long Rod Insulators with Ball and Socket Couplings "B" according to the Standard IEC 60433 (1998) and according to the former German Standard DIN 48006 / Part 1

Designation according to	Designation according to former	Core diameter d_2	Highest system voltage Um	Standard lightning impulse withstand voltage	Wet power frequency withstand voltage	Specified mechanical failing load	Routine mechanical test load	Minimum nominal creepage distance (16 mm/kV)	Maximum nominal length L	Standard coupling size (pin diameter) d_1
IEC 60433	DIN 48006/1	(mm)	(kV)	(kV)	(kV)	(kN)	(kN)	(mm)	(mm)	(mm)
L 40 B 170	LP 60/5/380	60	36	170	70	40	32	576	380	11
L 60 B 170	LP 60/5/390	60	36	170	70	60	48	576	400	
L 100 B 170	-	60	36	170	70	100	80	576	450	16
L 100 B 250	-		52	250	95	100	80	832	580	
L 100 B 325	LP 60/19/870		72.5	325	140	100	80	1160	870	
L 100 B 450	-		123	450	185	100	80	1968	1085	
L 100 B 550	LP 60/30/1240		123	550	230	100	80	1968	1240	
L 120 B 325	LP 60/19/870	60	72.5	325	140	120	96	1160	870	16
L 120 B 450	-		123	450	185	120	96	1968	1085	
L 120 B 550	LP 60/30/1240		123	550	230	120	96	1968	1240	
L 120 B 650	-		145	650	275	120	96	2320	1430	
L 160 B 325	LP 75/14/870	75	72.5	325	140	160	128	1160	885	20
L 160 B 450	-		123	450	185	160	128	1968	1100	
L 160 B 550	LP 75/22/1250		123	550	230	160	128	1968	1255	
L 160 B 650	-		145	650	275	160	128	2320	1445	
L 210 B 325	LP 85/14/900	85	72.5	325	140	210	168	1160	905	20
L 210 B 450	-		123	450	185	210	168	1968	1120	
L 210 B 550	LP 85/22 /1270		123	550	230	210	168	1968	1275	
L 210 B 650	-		145	650	275	210	168	2320	1465	
L 250 B 550	LP 95/22/1300	95	123	550	230	250	200	1968	1305	24
L 250 B 650	-		145	650	275	250	200	2320	1500	
L 300 B 550	LP 105/22/1330	105	123	550	230	300	240	1968	1330	24
L 300 B 650	-		145	650	275	300	240	2320	1520	

PPC INSULATORS

Long Rod Insulators
with Clevis and Tongue Couplings

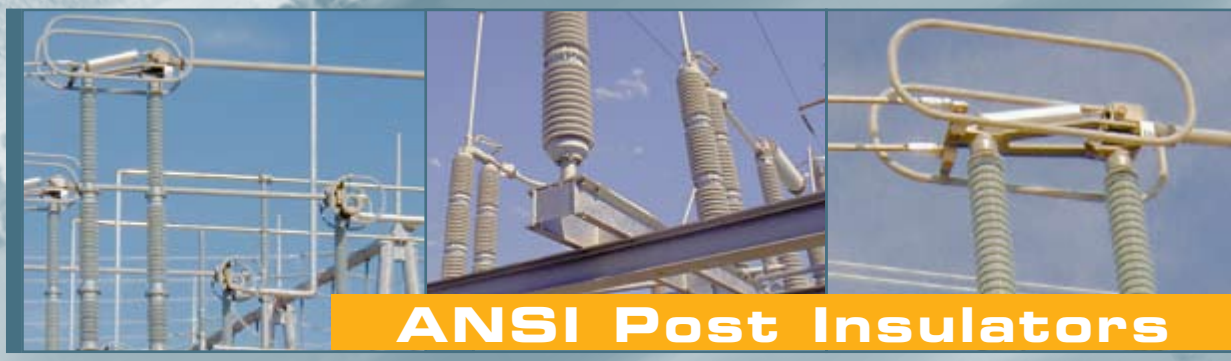


Characteristics of Long Rod Insulators with Clevis and Tongue Couplings "C" according to the Standard IEC 60433 (1998) and according to the former German Standard DIN 48006 / Part 2

Designation according to	Designation according to former	Core diameter d_2	Highest system voltage Um	Standard lightning impulse withstand voltage	Wet power frequency withstand voltage	Specified mechanical failing load	Routine mechanical test load	Minimum nominal creepage distance (16 mm/kV)	Maximum nominal length L	Standard coupling size (connecting bolt diameter) d_1
IEC 60433	DIN 48006/2	(mm)	(kV)	(kV)	(kV)	(kN)	(kN)	(mm)	(mm)	(mm)
L 100 C 170	-	60	36	170	70	100	80	576	475	19
L 100 C 250	-		52	250	95	100	80	832	605	
L 100 C 325	LG 60/14/860		72.5	325	140	100	80	1160	900	
L 100 C 450	-		123	450	185	100	80	1968	1120	
L 100 C 550	LG 60/30/1270		123	550	230	100	80	1968	1270	
L 120 C 325	LG 60/19/900	60	72.5	325	140	120	96	1160	905	19
L 120 C 450	-		123	450	185	120	96	1968	1120	
L 120 C 550	LG 60/30/1270		123	550	230	120	96	1968	1275	
L 120 C 650	-		145	650	275	120	96	2320	1465	
L 160 C 325	LG 75/14/900	75	72.5	325	140	160	128	1160	920	19
L 160 C 450	-		123	450	185	160	128	1968	1135	
L 160 C 550	LG 75/22/1270		123	550	230	160	128	1968	1290	
L 160 C 650	-		145	650	275	160	128	2320	1465	
L 210 C 325	LG 85/14/940	85	72.5	325	140	210	168	1160	940	22
L 210 C 450	-		123	450	185	210	168	1968	1155	
L 210 C 550	LG 85/22/1310		123	550	230	210	168	1968	1310	
L 210 C 650	-		145	650	275	210	168	2320	1500	
L 250 C 550	LG 95/22/1340	95	123	550	230	250	200	1968	1335	22
L 250 C 650	-		145	650	275	250	200	2320	1530	
L 300 C 550	LG 105/22/1370	105	123	550	230	300	240	1968	1365	25
L 300 C 650	-		145	650	275	300	240	2320	1560	

PPC INSULATORS

The very Best.



ANSI Post Insulators

PPC INSULATORS

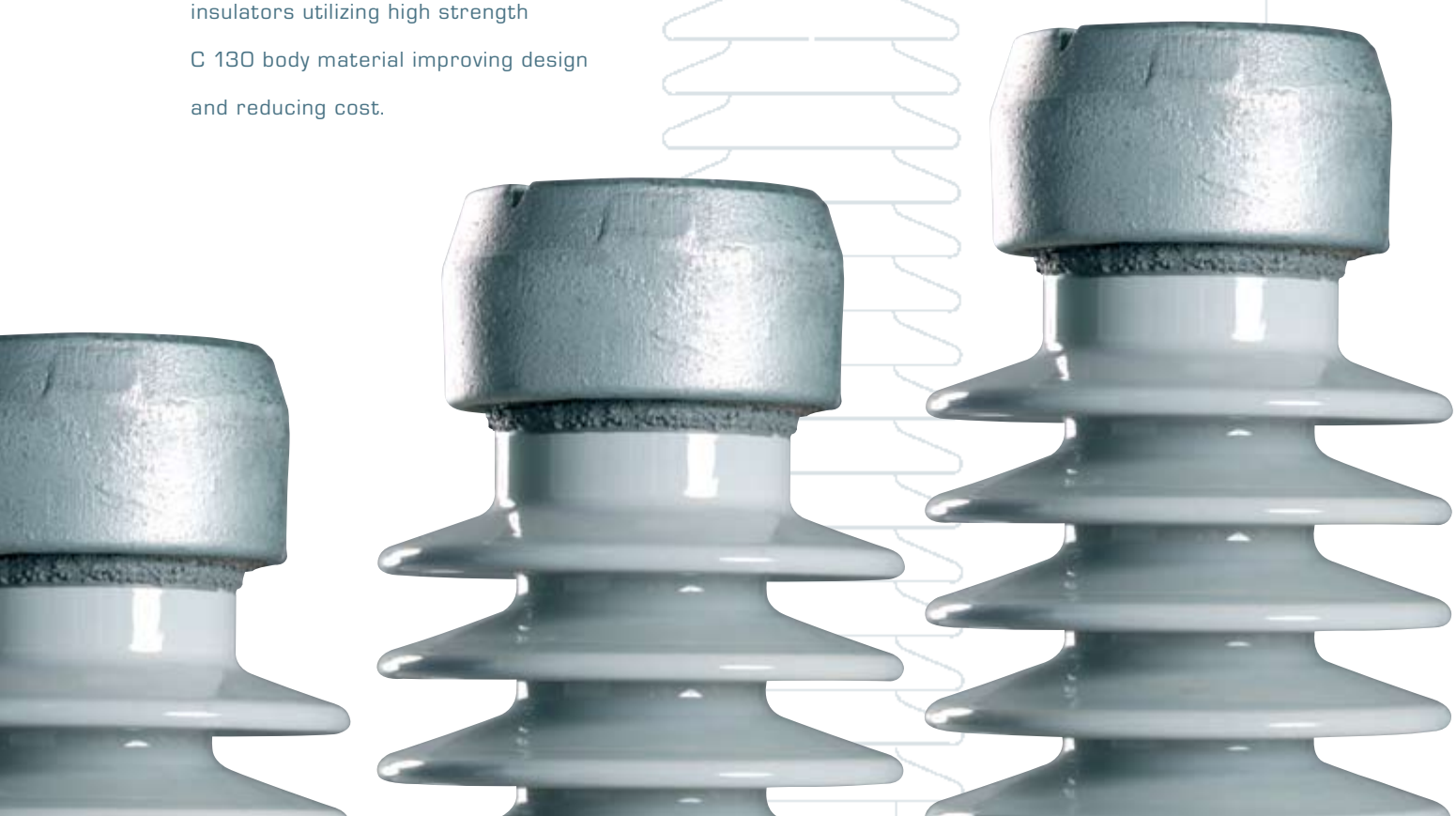
High Tech TR Post
Never comprom

Better Design enables higher performances with less weight

› ANSI

Under normal service conditions, the post insulator is subjected to extreme electrical and mechanical stresses. These stresses vary with environmental conditions and electro-mechanical demands.

PPC Insulators, with nearly a century of experience in designing and manufacturing porcelain high voltage insulators, has developed insulators utilizing high strength C 130 body material improving design and reducing cost.



Insulators.
ise on safety!

Index

PPC INSULATORS

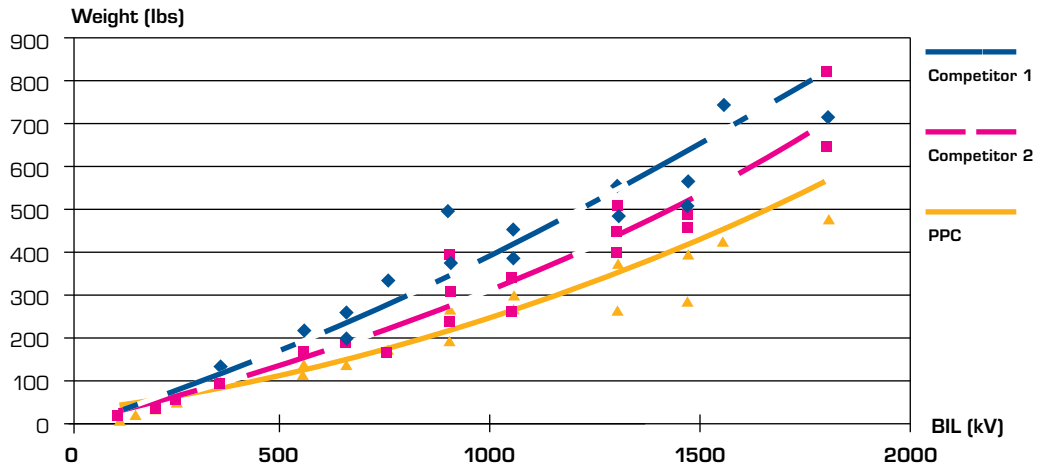
ANSI Post Insulators Design

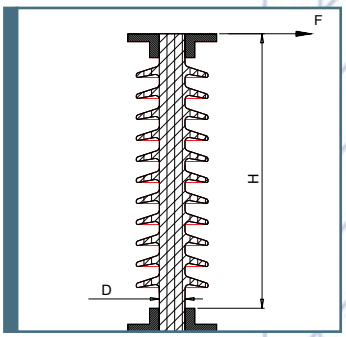
Mechanical design

In-service stresses on post insulators are mainly due to cantilever loads, (e.g., weight, wind force, seismic conditions, short circuit loads). A few applications require compression strength (e.g., capacitors banks) or torsional strength (e.g., rotating disconnectors) or tensile strength (e.g., underhung post insulator).

Cantilever strength is in direct relationship to the core diameter. Thus, a high-strength insulator provides a higher strength-to-weight ratio. Advantages include a smaller diameter, reduced quantity of and smaller sized fittings, and lighter post insulators with less visual impact. The high strength C 130 body also allows for a reduction in the number of components on insulators comprised of mutiple units. The advantages provided by the reduction of additional fittings include increased strike distance/creep and less assembly time. All insulators up to and including the TR 308 are availble in a one piece design.

The weight savings are clearly shown on the below graph (TR weight per BIL level).





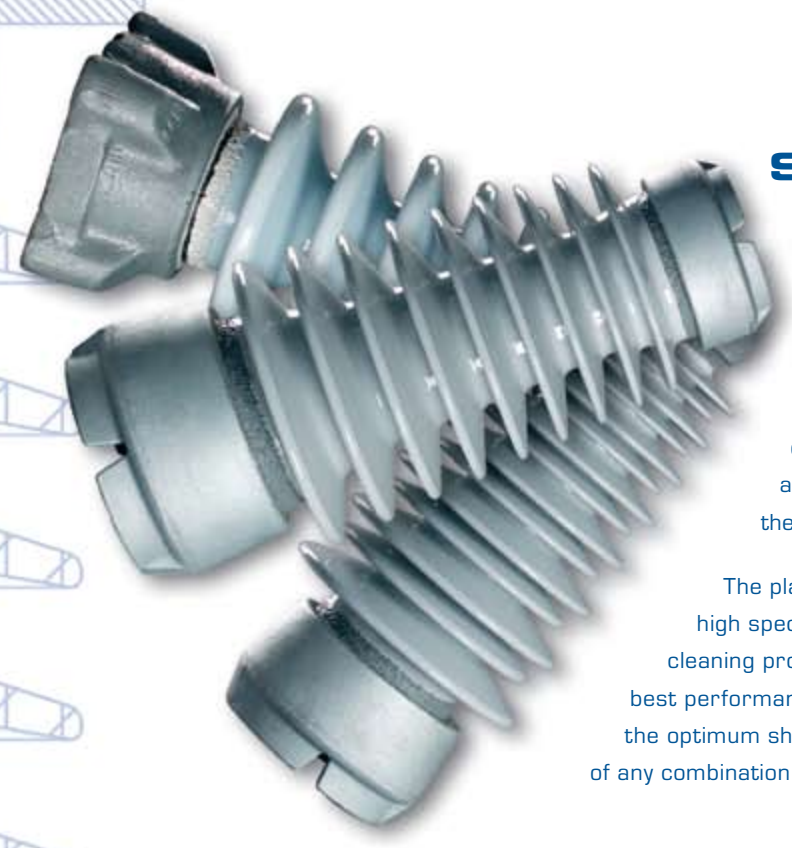
$\sigma = FxH / (I/V)$

$I/V = \pi/32 \times D^3$

Style

Some styles can be designed with different features, number of sections, uniform or tapered as well as upright or underhung. The following codes are used throughtout the catalog to clearly show the style.

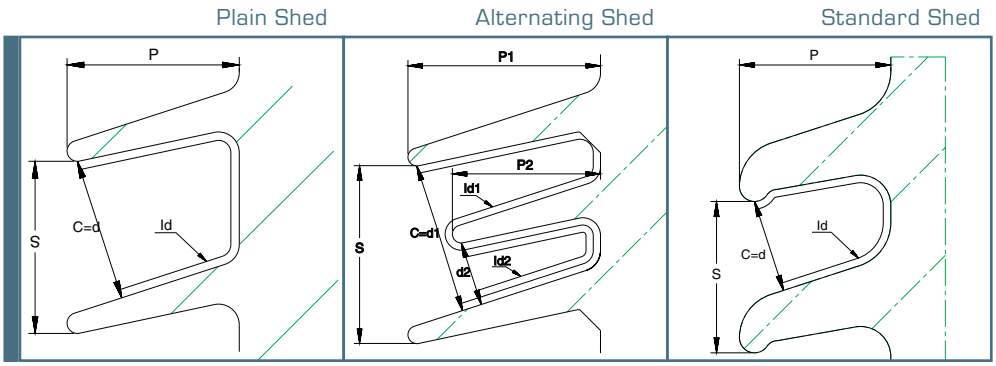
STYLE CODES		
U = Uniform, Upright and Underhung T = Tapered, Upright Only	S = Standard Strength H = High Strength E = Extra High Strength	P = Pollution, High Leakage Y = Higher Cantilever Option Z = Higher Cantilever Option



Shed design

The creepage distance required by ANSI C29.9 can be obtained with different shed designs. But some rules, which are the result from many years of experience acquired worldwide, are listed below in order to give you the best service for your long term benefit.

The plain alternative shed design offers high specific creepage distance and good self cleaning properties which usually provides best performance. Today, any design can have the optimum shed configuration consisting of any combination of sheds.



Parameters Characterizing Insulator Profile

1. Minimum distance, c, between sheds shall be ≥ 1.18 " (30 mm)

2. Ratio s/p between spacing and overhang ≥ 0.65

3. Ratio l_d/d between creepage distance and clearance

- This ratio must be calculated for the "worst case" on any section (ld_1/d_1, ld_2/d_2)
- It must be < 5

4. Alternating shed

- $p_1 - p_2 \geq 0.59"$ (15mm)

Parameters Characterizing Entire Insulator

As a post insulator can be designed with more than one section with different shed designs the following parameters are used for the entire insulator:

1. Creepage factor C.F.

- C.F.≤3.5 for pollution levels 1 and 2 (light and medium pollution level)
- C.F.≤4 for pollution levels 3 and 4 (heavy and very heavy pollution level)

C.F. = lt / St **lt** = creepage distance **St** = strike distance

2. Profile factor P.F.

- P.F. $= \frac{2p_1 + 2p_2 + s}{l}$ alternating sheds
- P.F. $= \frac{2p + s}{l}$ all other sheds

with **l** = creepage distance of the insulated leakage path measured between the two points which define **s**

- P.F. > 0.8 for pollution levels 1 and 2 (light and medium pollution level)
- P.F. > 0.7 for pollution levels 3 and 4 (heavy and very heavy pollution level)

ANSI Post Insulators

K-value Increased Pollution Performance Equalized Field Distribution

Basically, **K-value design** is a method to improve traditional creepage distance. In its full extent, K-value design is a method to reduce weight, volume and space while improving properties in-service by increasing pollution performance and equalizing electrical fields.

K-value is the unit for insulator shape and IEC 60507 defines the formula as form factor:

$$F = \int dl / p(l)$$

l is the creepage distance
p(l) is the circumference of the insulator as a function of l.

Form factor used as a design method is referred to as K-value and can be used for different types of improvements.

Creepage distance considers a leakage current as traveling over the insulator profile, in a linear path, identifying only distance.

K-value considers a leakage current as traveling along the insulator, over its complete surface. It calculates reduced diameter and/or increased creepage distance for higher resistance against the leakage currents. K-value identifies an insulator's total shape, i.e., geometric (ohmic) resistance against leakage currents.

The shape of the insulator must be calculated for the optimum design of pollution performance. The traditional calculation of creepage distance is sometimes sufficient, but to achieve the best performance in relation to material and space used, K-value design is necessary.

PPC Insulators offers complete computer design of K-value, integrated with electrical, mechanical, dimension and material calculations.

Design

Fittings

Fittings are made in malleable cast or ductile iron, hot dip galvanized according ASTM A-153M.

Standard Sizes	
3-inch bolt circle diameter:	4 tapped holes, 1/2 inch –13 +.015 oversize 1/2" Full Thread Depth (tap after hot dip galvanizing)
5-inch bolt circle diameter:	4 tapped holes, 5/8 inch-11 +.015 oversize. 5/8" Full Thread Depth (tap after hot dip galvanizing)
7-inch bolt circle diameter:	4 tapped holes, 3/4 inch-10 +.015 oversize. 3/4" Full Thread Depth (tap after hot dip galvanizing)
The holes are tapped 0.015" oversize to allow for use of galvanized cap screws.	
12-inch bolt circle diameter:	8 holes, according to drawings
14-inch bolt circle diameter:	8 holes, according to drawings

NOTE: When the insulator is made of more than one section, hardware required for assembly is delivered with the shipment.

RIV

If corona rings are necessary to meet the requirements, this is indicated in the tables.

ANSI Post Insulators Production

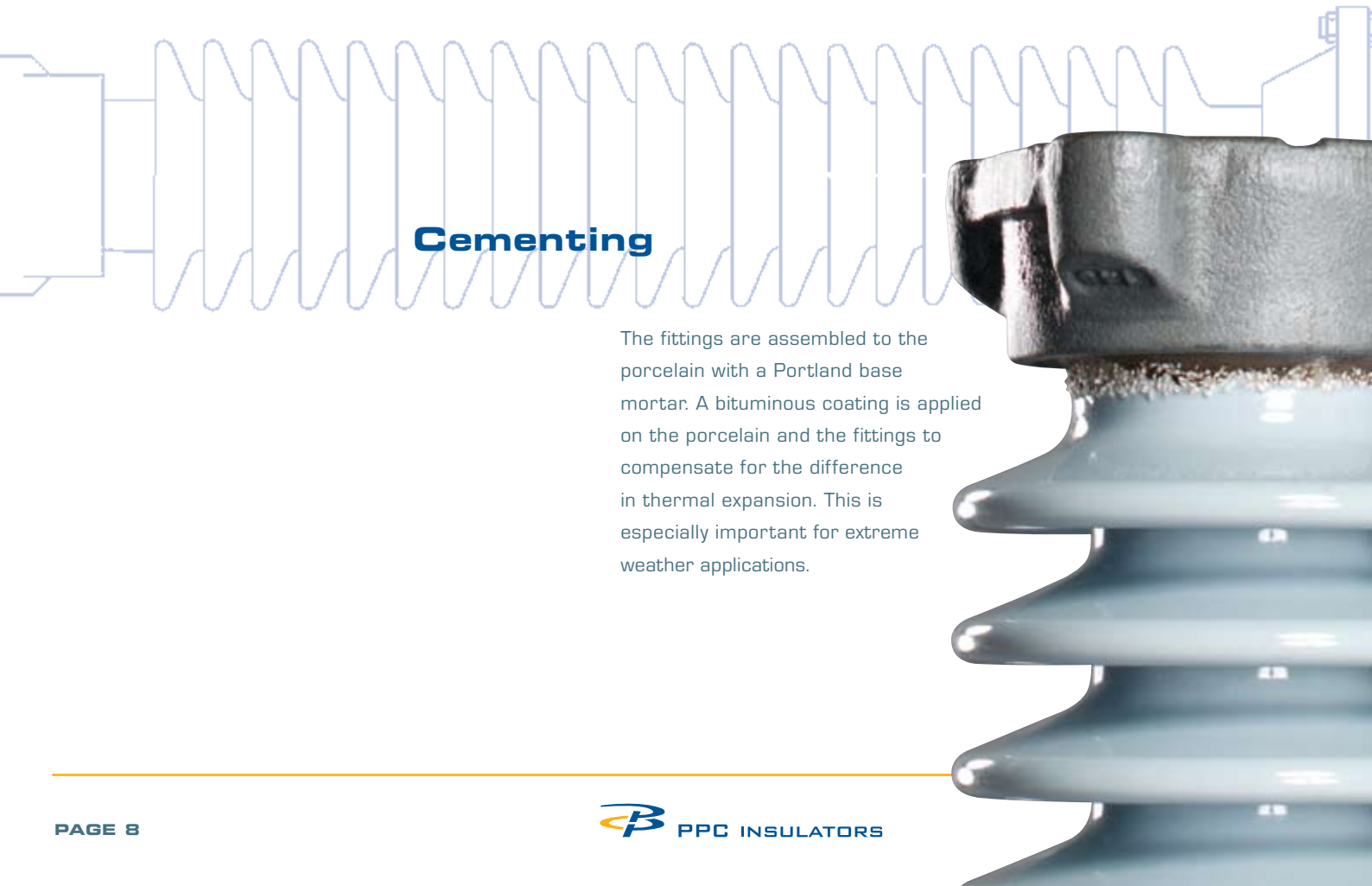
The **PPC** production facilities for TR station post insulators manufacture in full accordance with ANSI C29.9. Insulation requirements are available in ratings from 95kV to 2050kV BIL. Special requirements can be also offered upon request. This catalog, which includes standard ANSI TRs as well as extra high strength, additional creepage distance and different BCD, is updated continuously.

Glazing

Glazing is grey in accordance to ANSI Z55.1 and conforms to Munsell notation 5BG 7.0/0.4. Brown glaze is also available. Semi-conductive surface glazing can be provided for special polluted environments.

Cementing

The fittings are assembled to the porcelain with a Portland base mortar. A bituminous coating is applied on the porcelain and the fittings to compensate for the difference in thermal expansion. This is especially important for extreme weather applications.



Quality Assurance

Quality procedures are applied throughout the production process according to **ISO 9000**. Per **ANSI C29.9**, insulators are tested to confirm Design. Quality and Routine tests are performed on each unit throughout production.

Tested Items	Design Test § 7.2	Quality Conformance Test § 7.3	Routine Test § 7.4
Low Frequency Wet Withstand § 7.2.1	✓		
Critical Impulse Flashover, Positive § 7.2.2	✓		
Impulse Witstand § 7.2.3	✓		
Radio Influence Voltage § 7.2.4	✓		
Mechanical Failing load:			
›cantilever strength § 7.3.4		✓	
›tensile strength § 7.3.5		✓	
›compression strength § 7.2.6	✓		
›torsional strength § 7.2.7	✓		
Thermal Shock §7.2.5	✓		
Visual and Dimensional Tests §7.3.1		✓	
Porosity §7.3.2		✓	
Galvanizing Test §7.3.3		✓	
Mechanical Proof §7.4.2			✓

Post insulator mechanical strength is designed with regards to ANSI C29.9 cantilever ratings. Resulting mechanical values often exceed ANSI ratings for compression, torsion and tensile strengths. For standardization, ANSI ratings are used in the specification tables, pages 10 - 26. Actual ultimate breaking values are available upon request.

Tolerances

› **Alignment of fixing holes**

The line between two opposite axes of holes of the top fitting have to be in line with corresponding line of the bottom fitting within the specified angle.

1° standard

› **Coaxiality and concentricity**

The center line of the pitch circle diameter of the two fittings should fit into a cylinder with diameter equal to

2 x (0.5 + height of insulator in meters) **mm**

or **0.002 x** (20+ height of insulator in inches) **in**

› **Plane parallelism**

0.5 x (height of insulator in meters) **mm**

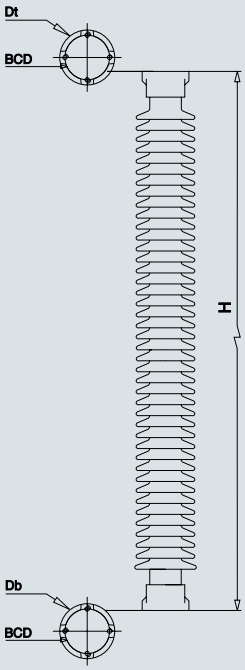
or **0.0005 x** (height of insulator in inches) **in**

Conversion Table

1 inch	25.4 mm
1 pound	4.448 N
1 inch-pound	0.113 Nm

ANSI Post Insulators

95 kV-110 kV BIL



BIL	95 kV			110 kV		
STYLE	**UNIFORM**			**UNIFORM**		
CATALOG NUMBER	95 SU	95 HU	95 EU	110 SU	110 HU	110 EU
ANSI TECHNICAL REFERENCE	TR202	TR222		TR205	TR225	
NON ANSI DECSCRIPTION	95-2000	95-4000	95-8000	110-2000	110-4000	110-8000
Dimensions						
Leakage Distance (in)	10.5	10.5	10.5	15.5	15.5	17
Height (in)	7.5	10	10	10	12	12
Max Shed Diameter (in)	7.1	8	8.9	7	8.2	10.2
Top BCD (in)	3	5	5	3	5	5
Diameter Dt (in)	3.9	6.2	6.2	4.1	6.2	6.3
Bottom BCD (in)	3	5	5	3	5	5
Diameter Db (in)	3.9	6.2	6.2	4.1	6.2	6.3
Mechanical Values						
Cantilever Strength, Upright, Pounds	2000	4000	8000	2000	4000	8000
Tensile Strength, Pounds	7000	20000	28000	85000	20000	28000
Torsion Strength, Inch-Pounds	6000	30000	40000	7000	14000	40000
Compression Strength, Pounds	10000	100000	40000	10000	20000	40000
Electrical Values						
Impulse Flashover, Positive, kV	105	105	105	125	125	125
Low Frequency Withstand, 10 Sec. Wet, kV	30	30	30	45	45	45
Impulse Withstand, kV	95	95	95	110	110	110
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	5	5	5	10	10	10
Maximum RIV, Microvolts at 1000kHz	50	50	50	50	50	50
Weight						
Approximate Net Weight, Pounds	13	31	37	17	38	53

S = Standard Strength
H = High Strength
E = Extra High Strength

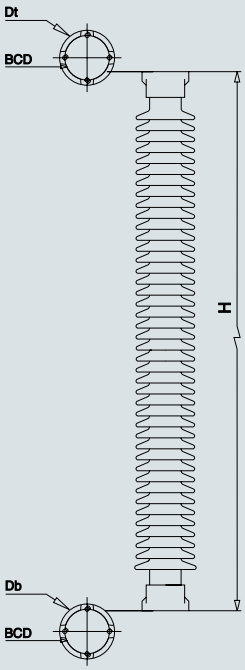
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

150 kV-200 kV BIL



BIL	150 kV			200 kV		
STYLE	**UNIFORM**			**UNIFORM**		
CATALOG NUMBER	150 SU	150 HU	150 EU	200 SU	200 HU	200 EU
ANSI TECHNICAL REFERENCE	TR208	TR227		TR210	TR231	
NON ANSI DECSCRIPTION	150-2000	150-4000	150-8000	200-2000	200-4000	200-8000
Dimensions						
Leakage Distance (in)	24	24	24	37	37	37
Height (in)	14	15	15	18	20	20
Max Shed Diameter (in)	6.3	7.1	10.8	6.9	8.6	11.9
Top BCD (in)	3	5	5	3	5	5
Diameter Dt (in)	4.3	6.2	6.3	5	6.4	6.7
Bottom BCD (in)	3	5	5	3	5	5
Diameter Db (in)	4.3	6.2	6.3	5	6.4	6.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	2000	4000	8000	2000	4000	8000
Tensile Strength, Pounds	10000	20000	28000	12000	25000	28000
Torsion Strength, Inch-Pounds	8000	16000	40000	10000	20000	40000
Compression Strength, Pounds	10000	20000	40000	15000	30000	60000
Electrical Values						
Impulse Flashover, Positive, kV	170	170	170	225	225	225
Low Frequency Withstand, 10 Sec. Wet, kV	60	60	60	80	80	80
Impulse Withstand, kV	150	150	150	200	200	200
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	15	15	15	22	22	22
Maximum RIV, Microvolts at 1000kHz	100	100	100	100	100	100
Weight						
Approximate Net Weight, Pounds	29	41	66	47	81	111

S = Standard Strength
H = High Strength
E = Extra High Strength

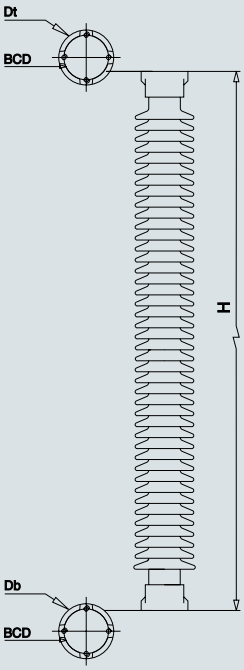
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

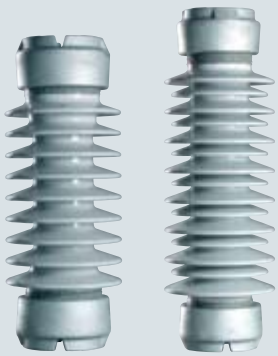
P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

250 kV-350 kV BIL





BIL	250 kV			350 kV		
STYLE	**UNIFORM**			**UNIFORM**		
CATALOG NUMBER	250 SU	250 HU	250 EU	350 SU	350 HU	350 EU
ANSI TECHNICAL REFERENCE	TR214	TR267		TR216	TR278	
NON ANSI DECSCRIPTION	250-2000	250-4000	250-8000	350-1500	350-3000	350-6000
Dimensions						
Leakage Distance (in)	43	43	43	72	72	72
Height (in)	22	24	25	30	30	32
Max Shed Diameter (in)	7.3	9	10.6	7.1	9.8	11.1
Top BCD (in)	3	5	7	3	5	7
Diameter Dt (in)	5	6.4	8.7	5	6.4	8.7
Bottom BCD (in)	3	5	7	3	5	7
Diameter Db (in)	5	6.4	8.7	5	6.4	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	2000	4000	8000	1500	3000	6000
Tensile Strength, Pounds	14000	28000	28000	16000	25000	40000
Torsion Strength, Inch-Pounds	12000	84000	90000	15000	71000	90000
Compression Strength, Pounds	15000	100000	120000	25000	100000	120000
Electrical Values						
Impulse Flashover, Positive, kV	280	280	280	390	390	390
Low Frequency Withstand, 10 Sec. Wet, kV	100	100	100	145	145	145
Impulse Withstand, kV	250	250	250	350	350	350
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	30	30	30	44	44	44
Maximum RIV, Microvolts at 1000kHz	200	200	200	200	200	200
Weight						
Approximate Net Weight, Pounds	53	94	168	73	124	202

S = Standard Strength
H = High Strength
E = Extra High Strength

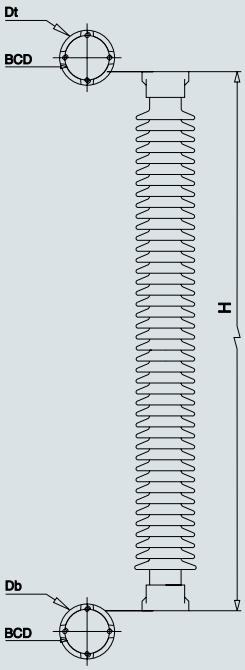
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

550 kV BIL



BIL	550 kV					
STYLE	UNIFORM			UNIFORM		
				HIGH LEAKAGE		
CATALOG NUMBER	550 SU	550 HU	550 EU	550 SUP	550 HUP	550 EUP
ANSI TECHNICAL REFERENCE	TR286	TR287				
NON ANSI DECSCRIPTION	550-1700	550-2600	550-5000	550-1700	550-2600	550-5000
Dimensions						
Leakage Distance (in)	99	99	95	125	125	120
Height (in)	45	45	45	45	45	45
Max Shed Diameter (in)	7.3	7.1	10.4	9.3	10	11.5
Top BCD (in)	5	5	7	5	5	7
Diameter Dt (in)	6.3	6.3	8.7	6.3	6.3	8.7
Bottom BCD (in)	5	5	7	5	5	7
Diameter Db (in)	6.3	6.3	8.7	6.3	6.3	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1700	2600	5000	1700	2600	5000
Tensile Strength, Pounds	25000	36000	40000	20000	25000	40000
Torsion Strength, Inch-Pounds	40000	90000	120000	40000	90000	120000
Compression Strength, Pounds	60000	150000	120000	60000	75000	120000
Electrical Values						
Impulse Flashover, Positive, kV	610	610	610	610	610	610
Low Frequency Withstand, 10 Sec. Wet, kV	230	230	230	230	230	230
Impulse Withstand, kV	550	550	550	550	550	550
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	73	73	73	73	73	73
Maximum RIV, Microvolts at 1000kHz	200	200	200	200	200	200
Weight						
Approximate Net Weight, Pounds	124	118	262	147	178	276

S = Standard Strength
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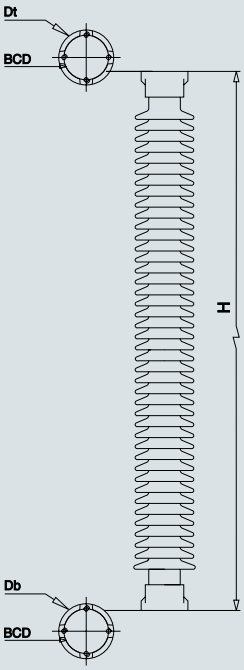
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

650 kV BIL



BIL	650 kV					
STYLE	UNIFORM			UNIFORM		
				HIGH LEAKAGE		
CATALOG NUMBER	650 SU	650 HU	650 EU	650 SUP	650 HUP	650 EUP
ANSI TECHNICAL REFERENCE	TR288	TR289				
NON ANSI DECSCRIPTION	650-1450	650-2200	650-4100	650-1450	650-2200	650-4100
Dimensions						
Leakage Distance (in)	116	116	116	155	155	150
Height (in)	54	54	54	54	54	54
Max Shed Diameter (in)	7.3	7.8	10.2	9.5	9.9	11.7
Top BCD (in)	5	5	7	5	5	7
Diameter Dt (in)	6.3	6.7	8.7	6.3	6.3	8.7
Bottom BCD (in)	5	5	7	5	5	7
Diameter Db (in)	6.3	6.7	8.7	6.3	6.3	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1000	2200	4100	1450	2200	4100
Tensile Strength, Pounds	20000	36000	40000	20000	25000	40000
Torsion Strength, Inch-Pounds	40000	133000	120000	60000	90000	120000
Compression Strength, Pounds	60000	150000	120000	60000	75000	120000
Electrical Values						
Impulse Flashover, Positive, kV	710	710	710	710	710	710
Low Frequency Withstand, 10 Sec. Wet, kV	275	275	275	275	275	275
Impulse Withstand, kV	650	650	650	650	650	650
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	88	88	88	88	88	88
Maximum RIV, Microvolts at 1000kHz	200	200	200	200	200	200
Weight						
Approximate Net Weight, Pounds	139	195	308	191	213	287

S = Standard Strength
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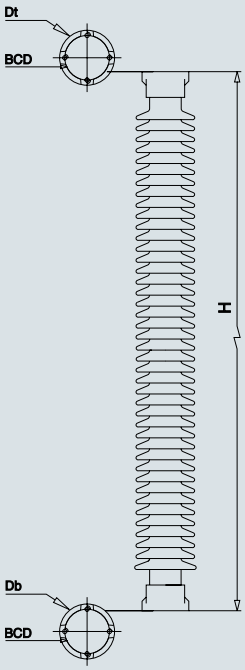
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

750 kV BIL



BIL	750 kV					
STYLE	UNIFORM			UNIFORM		
				HIGH LEAKAGE		
CATALOG NUMBER	750 SU	750 HU	750 EU	750 SUP	750 HUP	750 EUP
ANSI TECHNICAL REFERENCE	TR291	TR295				
NON ANSI DECSCRIPTION	750-1200	750-1850	750-3500	750-1200	750-1850	750-3500
Dimensions						
Leakage Distance (in)	132	132	132	180	180	180
Height (in)	62	62	62	62	62	62
Max Shed Diameter (in)	7.3	8.6	10.2	9.5	10	11.6
Top BCD (in)	5	5	7	5	5	7
Diameter Dt (in)	6.2	6.7	8.7	6.3	6.3	8.7
Bottom BCD (in)	5	5	7	5	5	7
Diameter Db (in)	6.2	6.7	8.7	6.3	6.3	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1200	1850	3500	1200	1850	3500
Tensile Strength, Pounds	20000	25000	40000	20000	25000	40000
Torsion Strength, Inch-Pounds	40000	90000	120000	40000	90000	120000
Compression Strength, Pounds	60000	75000	120000	60000	75000	120000
Electrical Values						
Impulse Flashover, Positive, kV	810	810	810	810	810	810
Low Frequency Withstand, 10 Sec. Wet, kV	315	315	315	315	315	315
Impulse Withstand, kV	750	750	750	750	750	750
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	103	103	103	103	103	103
Maximum RIV, Microvolts at 1000kHz	500	500	500	500	500	500
Weight						
Approximate Net Weight, Pounds	157	230	341	216	242	386

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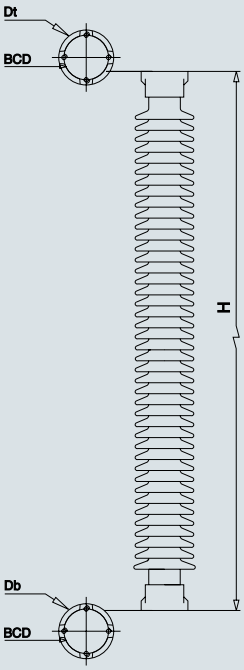
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

900 kV BIL



BIL	900 kV				
STYLE	TAPERED		UNIFORM		
CATALOG NUMBER	900 HT	900 ET	900 SU	900 HU	900 EU
ANSI TECHNICAL REFERENCE	TR308		TR304	TR308	
NON ANSI DECSCRIPTION	900-1450	900-2750	900-950	900-1450	900-2750
Dimensions					
Leakage Distance (in)	170	173	166	173	167
Height (in)	80	80	80	80	80
Max Shed Diameter (in)	7.5	8.6	6.7	7.7	8.6
Top BCD (in)	5	5	5	5	7
Diameter Dt (in)	6.3	6.3	6.2	6.7	8.7
Bottom BCD (in)	5	7	5	5	7
Diameter Db (in)	6.7	8.7	6.2	6.7	8.7
Mechanical Values					
Cantilever Strength, Upright, Pounds	1450	2750	950	1450	2750
Tensile Strength, Pounds	25000	25000	20000	25000	40000
Torsion Strength, Inch-Pounds	90000	90000	60000	90000	133000
Compression Strength, Pounds	75000	90000	60000	90000	150000
Electrical Values					
Impulse Flashover, Positive, kV	1010	1010	1010	1010	1010
Low Frequency Withstand, 10 Sec. Wet, kV	385	385	385	385	385
Impulse Withstand, kV	900	900	900	900	900
Radio Influence Voltage Data					
Test Voltage, Rms to Ground, kV	146	146	146	146	146
Maximum RIV, Microvolts at 1000kHz	500	500	500	500	500
Weight					
Approximate Net Weight, Pounds	236	313	170	254	342

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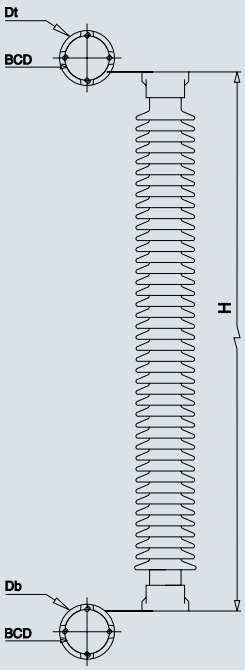
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

900 kV BIL



BIL	900 kV					
STYLE	TAPERED			UNIFORM	TAPERED	
	HIGH STRENGTH			HIGH LEAKAGE		
CATALOG NUMBER	900 YT	900 ZT		900 SUP	900 HTP	900 ETP
ANSI TECHNICAL REFERENCE						
NON ANSI DECSCRIPTION	900-3000	900-4000		900-950	900-1450	900-2750
Dimensions						
Leakage Distance (in)	165	171		227	229	228
Height (in)	80	80		80	80	80
Max Shed Diameter (in)	8.7	9.4		7.8	8.8	9.8
Top BCD (in)	5	5		5	5	5
Diameter Dt (in)	6.3	6.3		6.2	6.3	6.3
Bottom BCD (in)	7	12		5	5	7
Diameter Db (in)	8.7	13.2		6.2	6.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	3000	4000		950	1450	2750
Tensile Strength, Pounds	25000	31500		20000	25000	25000
Torsion Strength, Inch-Pounds	90000	88500		60000	90000	90000
Compression Strength, Pounds	75000	260000		60000	75000	90000
Electrical Values						
Impulse Flashover, Positive, kV	1010	1010		1010	1010	1010
Low Frequency Withstand, 10 Sec. Wet, kV	385	385		385	385	385
Impulse Withstand, kV	900	900		900	900	900
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	146	146		146	146	146
Maximum RIV, Microvolts at 1000kHz	500	500		500	500	500
Weight						
Approximate Net Weight, Pounds	326	381		201	272	353

S = Standard Strength
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U = Uniform, Upright and Underhung
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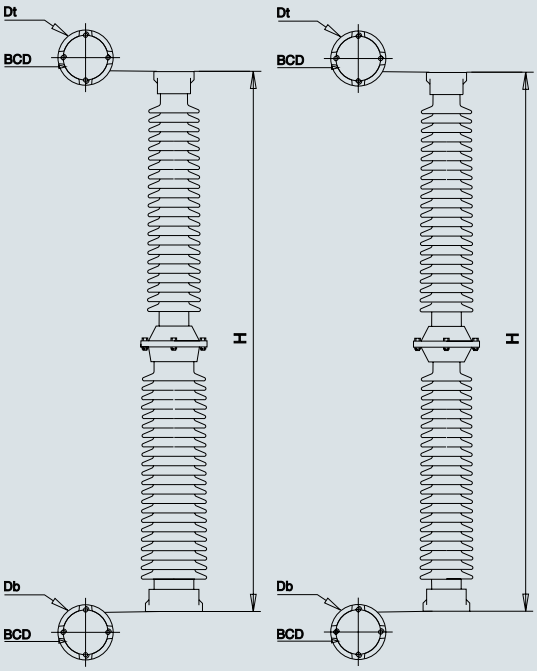
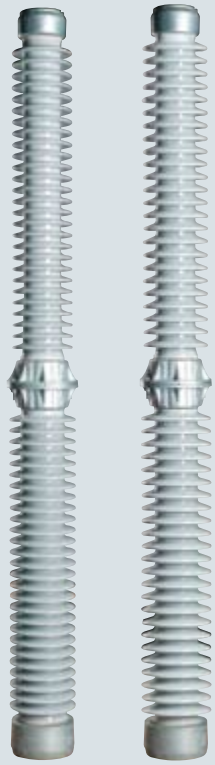
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1050 kV BIL





BIL	1050 kV					
STYLE	TAPERED			UNIFORM		
CATALOG NUMBER	1050 ST	1050 HT	1050 ET	1050 SU	1050 HU	1050 EU
ANSI TECHNICAL REFERENCE	TR312	TR316		TR312	TR316	TR362
NON ANSI DECSCRIPTION	1050-800	1050-1250	1050-2300	1050-800	1050-1250	1050-2300
Dimensions						
Leakage Distance (in)	205	204	206	209	207	207
Height (in)	92	92	92	92	92	92
Max Shed Diameter (in)	7.4	8	9.3	7.4	8.4	9.3
Top BCD (in)	5	5	5	5	5	7
Diameter Dt (in)	6.2	6.3	6.3	6.2	6.7	8.7
Bottom BCD (in)	5	5	7	5	5	7
Diameter Db (in)	6.2	6.7	8.7	6.2	6.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	800	1250	2300	800	1250	2300
Tensile Strength, Pounds	20000	25000	25000	20000	25000	40000
Torsion Strength, Inch-Pounds	40000	90000	90000	40000	90000	90000
Compression Strength, Pounds	60000	90000	90000	60000	90000	90000
Electrical Values						
Impulse Flashover, Positive, kV	1210	1210	1210	1210	1210	1210
Low Frequency Withstand, 10 Sec. Wet, kV	455	455	455	455	455	455
Impulse Withstand, kV	1050	1050	1050	1050	1050	1050
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	146	146	146	146	146	146
Maximum RIV, Microvolts at 1000kHz	500	500	500	500	500	500
Weight						
Approximate Net Weight, Pounds	223	311	366	238	349	428

S = Standard Strength
H = High Strength
E = Extra High Strength

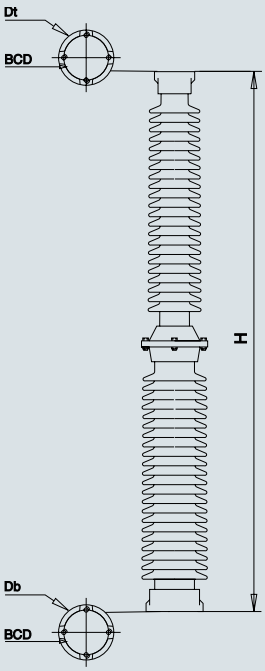
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1050 kV BIL



BIL	1050 kV					
STYLE	TAPERED					
	HIGH STRENGTH			HIGH LEAKAGE		
CATALOG NUMBER	1050 YT	1050 ZT		1050 STP	1050 HTP	1050 ETP
ANSI TECHNICAL REFERENCE						
NON ANSI DECSCRIPTION	1050-3500	1050-5000		1050-800	1050-1250	1050-2300
Dimensions						
Leakage Distance (in)	209	317		268	271	270
Height (in)	92	92		92	92	92
Max Shed Diameter (in)	10.4	13.5		8.7	9.5	10.4
Top BCD (in)	7	7		5	5	5
Diameter Dt (in)	8.7	8.7		6.2	6.3	6.3
Bottom BCD (in)	12	11.8		5	5	7
Diameter Db (in)	13.2	13.2		6.2	6.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	3500	5000		800	1250	2300
Tensile Strength, Pounds	40000	40000		20000	25000	25000
Torsion Strength, Inch-Pounds	133000	115000		40000	90000	90000
Compression Strength, Pounds	150000	120000		60000	90000	90000
Electrical Values						
Impulse Flashover, Positive, kV	1210	1210		1210	1210	1210
Low Frequency Withstand, 10 Sec. Wet, kV	455	455		455	455	455
Impulse Withstand, kV	1050	1050		1050	1050	1050
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	146	146		146	146	146
Maximum RIV, Microvolts at 1000kHz	500	500		500	500	500
Weight						
Approximate Net Weight, Pounds	492	626		258	357	404

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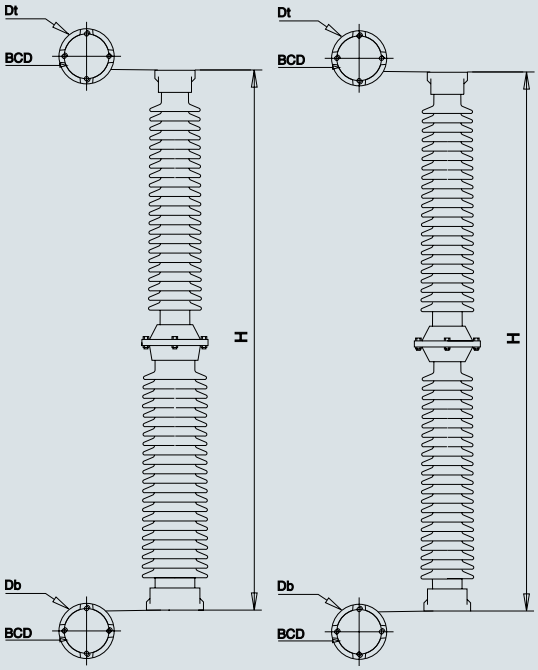
T = Tapered, Upright Only

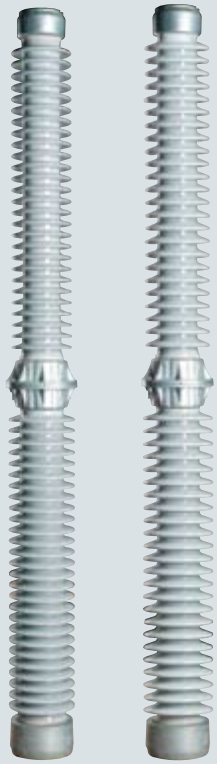
P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1300 kV BIL





BIL	1300 kV					
STYLE	TAPERED			UNIFORM		
CATALOG NUMBER	1300 ST	1300 HT	1300 ET	1300 SU	1300 HU	1300 EU
ANSI TECHNICAL REFERENCE	TR324	TR367	TR369	TR324		TR368
NON ANSI DECSCRIPTION	1300-1000	1300-1450	1300-2050	1300-1000	1300-1450	1300-2050
Dimensions						
Leakage Distance (in)	241	232	234	242	244	240
Height (in)	106	106	106	106	106	106
Max Shed Diameter (in)	8	8.3	9.2	8	8.6	9.3
Top BCD (in)	5	5	5	5	7	7
Diameter Dt (in)	6.3	6.2	6.3	6.3	8.7	8.7
Bottom BCD (in)	5	7	7	5	7	7
Diameter Db (in)	6.3	8.7	8.7	6.3	8.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1000	1450	2050	1000	1450	2050
Tensile Strength, Pounds	25000	20000	40000	25000	20000	40000
Torsion Strength, Inch-Pounds	90000	40000	90000	90000	40000	120000
Compression Strength, Pounds	75000	60000	150000	75000	60000	120000
Electrical Values						
Impulse Flashover, Positive, kV	1410	1410	1410	1410	1410	1410
Low Frequency Withstand, 10 Sec. Wet, kV	525	525	525	525	525	525
Impulse Withstand, kV	1300	1300	1300	1300	1300	1300
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	220	220	220	220	220	220
Maximum RIV, Microvolts at 1000kHz	1000	1000	1000	1000	1000	1000
Weight						
Approximate Net Weight, Pounds	324	320	457	326	406	512

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P = Pollution/High Leakage
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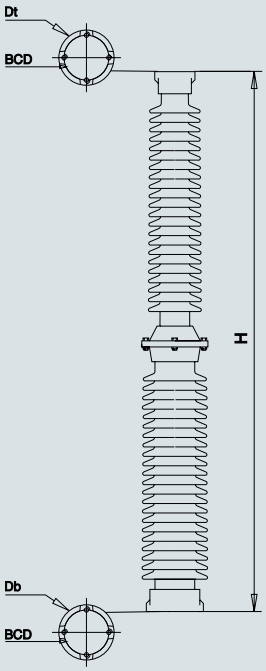
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1300 kV BIL



BIL	1300 kV					
STYLE	TAPERED					
	HIGH STRENGTH			HIGH LEAKAGE		
CATALOG NUMBER	1300 YT	1300 ZT		1300 STP	1300 HTP	1300 ETP
ANSI TECHNICAL REFERENCE						
NON ANSI DECSCRIPTION	1300-3000	1300-4000		1300-1000	1300-1450	1300-2050
Dimensions						
Leakage Distance (in)	237	233		326	322	315
Height (in)	106	106		106	106	106
Max Shed Diameter (in)	10	10.5		9.1	9.7	10.5
Top BCD (in)	5	5		5	5	5
Diameter Dt (in)	6.3	6.3		6.3	6.2	6.3
Bottom BCD (in)	12	11.8		5	7	7
Diameter Db (in)	13.2	13.2		6.3	8.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	3000	4000		1000	1450	2050
Tensile Strength, Pounds	40000	40000		25000	20000	40000
Torsion Strength, Inch-Pounds	133000	133000		90000	40000	90000
Compression Strength, Pounds	150000	150000		75000	60000	150000
Electrical Values						
Impulse Flashover, Positive, kV	1410	1410		1410	1410	1410
Low Frequency Withstand, 10 Sec. Wet, kV	525	525		525	525	525
Impulse Withstand, kV	1300	1300		1300	1300	1300
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	220	220		220	220	220
Maximum RIV, Microvolts at 1000kHz	1000	1000		1000	1000	1000
Weight						
Approximate Net Weight, Pounds	507	544		357	381	505

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Z = Higher Cantilever Option

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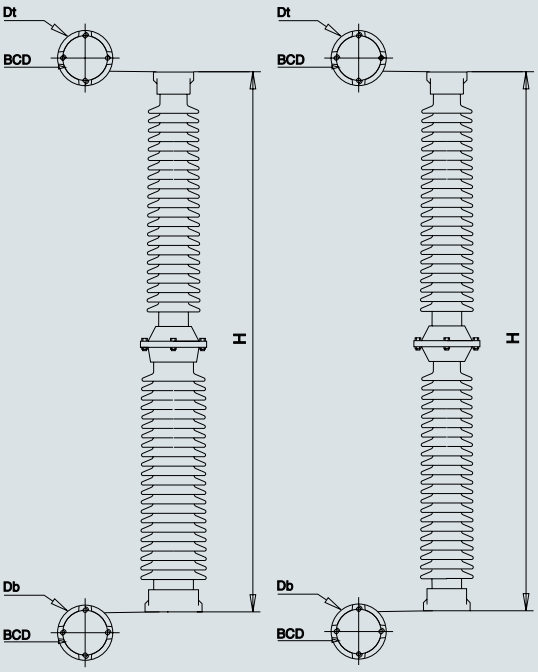
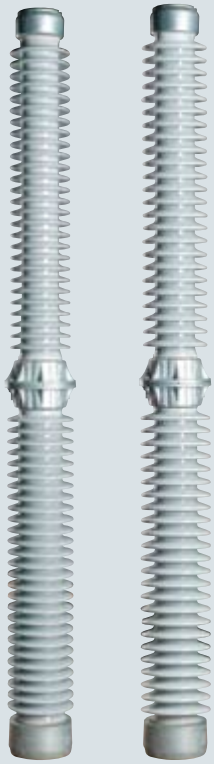
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1470 kV BIL





BIL	1470 kV					
STYLE	TAPERED				UNIFORM	
			HIGH LEAKAGE			
CATALOG NUMBER	1470 HT	1470 ET	1470 HTP	1470 ETP	1470 SU	1470 EU
ANSI TECHNICAL REFERENCE	TR371	TR373			TR330	TR372
NON ANSI DECSCRIPTION	1470-1170	1470-1750	1470-1000	1470-1750	1470-900	1470-1750
Dimensions						
Leakage Distance (in)	273	274	376	373	272	273
Height (in)	122	122	122	122	122	122
Max Shed Diameter (in)	8.2	8.9	9.1	10.1	8	9
Top BCD (in)	5	5	5	5	5	7
Diameter Dt (in)	6.2	6.2	6.3	6.3	6.7	8.7
Bottom BCD (in)	7	7	5	7	5	7
Diameter Db (in)	8.7	8.7	6.7	8.7	6.7	8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1170	1750	1000	1750	900	1750
Tensile Strength, Pounds	20000	20000	25000	25000	25000	40000
Torsion Strength, Inch-Pounds	40000	40000	90000	90000	90000	120000
Compression Strength, Pounds	60000	60000	90000	90000	75000	100000
Electrical Values						
Impulse Flashover, Positive, kV	1610	1610	1610	1610	1610	1610
Low Frequency Withstand, 10 Sec. Wet, kV	590	590	590	590	590	590
Impulse Withstand, kV	1470	1470	1470	1470	1470	1470
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	220	220	220	220	220	220
Maximum RIV, Microvolts at 1000kHz	1000	1000	1000	1000	1000	1000
Weight						
Approximate Net Weight, Pounds	368	421	426	505	410	532

S = Standard Strength
H = High Strength
E = Extra High Strength

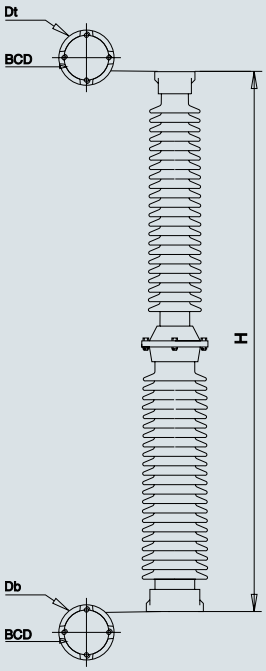
U = Uniform, Upright and Underhung
T = Tapered, Upright Only

P = Pollution/High Leakage
Y = Higher Cantilever Option
Z = Higher Cantilever Option

BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1550 kV BIL



BIL	1550 kV					
STYLE	TAPERED					
				HIGH LEAKAGE		
CATALOG NUMBER	1550 ST	1550 HT	1550 ET			1550 HTP
ANSI TECHNICAL REFERENCE		TR379				
NON ANSI DECSCRIPTION	1550-1000	1550-1700	1550-2500			1550-1700
Dimensions						
Leakage Distance (in)	334	283	315			373
Height (in)	128	128	128			128
Max Shed Diameter (in)	8.7	8.9	10.4			9.9
Top BCD (in)	5	5	5			5
Diameter Dt (in)	6.2	6.2	6.2			6.3
Bottom BCD (in)	7	7	14			7
Diameter Db (in)	8.7	8.7	15.7			8.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1000	1700	2500			1700
Tensile Strength, Pounds	20000	20000	25000			25000
Torsion Strength, Inch-Pounds	60000	40000	60000			90000
Compression Strength, Pounds	60000	60000	60000			90000
Electrical Values						
Impulse Flashover, Positive, kV	1710	1710	1710			1710
Low Frequency Withstand, 10 Sec. Wet, kV	620	620	620			620
Impulse Withstand, kV	1550	1550	1550			1550
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	318	318	318			318
Maximum RIV, Microvolts at 1000kHz	2000	2000	2000			2000
Weight						
Approximate Net Weight, Pounds	413	457	617			516

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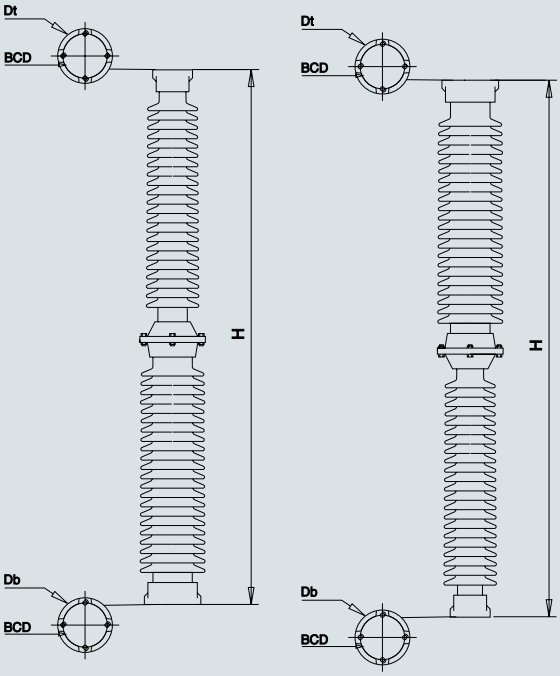
BCD = Bolt Circle Diameter
Dt = Diameter Top Fitting
Db = Diameter Bottom Fitting

ANSI Post Insulators

1800 kV BIL



BIL	1800 kV					
STYLE	TAPERED					
			HIGH STRENGTH		HIGH LEAKAGE	
CATALOG NUMBER	1800 ST	1800 HT	1800 YT		1800 STP	1800 ETP
ANSI TECHNICAL REFERENCE	TR391					
NON ANSI DECSCRIPTION	1800-1400	1800-1750	1800-3500		1800-1400	1800-2500
Dimensions						
Leakage Distance (in)	340	346	337		450	371
Height (in)	152	152	152		152	152
Max Shed Diameter (in)	8.8	10.1	10.9		9.8	10.5
Top BCD (in)	5	5	5		5	5
Diameter Dt (in)	6.2	6.2	6.7		6.2	6.3
Bottom BCD (in)	7	14	14		7	14
Diameter Db (in)	8.7	15.7	15.4		8.7	15.7
Mechanical Values						
Cantilever Strength, Upright, Pounds	1400	1750	3500		1400	2500
Tensile Strength, Pounds	20000	20000	35000		20000	25000
Torsion Strength, Inch-Pounds	40000	60000	133000		60000	90000
Compression Strength, Pounds	60000	60000	150000		60000	90000
Electrical Values						
Impulse Flashover, Positive, kV	2000	2000	2000		2000	2000
Low Frequency Withstand, 10 Sec. Wet, kV	710	710	710		710	710
Impulse Withstand, kV	1800	1800	1800		1800	1800
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	318	318	318		318	318
Maximum RIV, Microvolts at 1000kHz	2000	2000	2000		2000	2000
Weight						
Approximate Net Weight, Pounds	527	651	933		585	763

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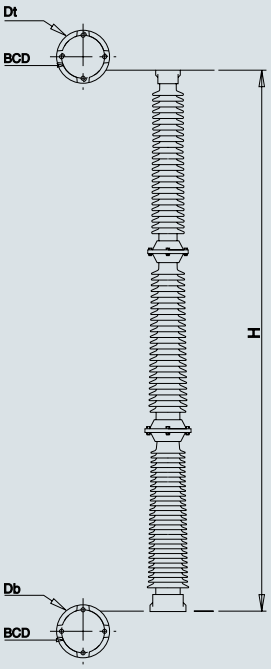
Db = Diameter Bottom Fitting

ANSI Post Insulators

2050 kV BIL



BIL	2050 kV					
STYLE	TAPERED					
				HIGH LEAKAGE		
CATALOG NUMBER	2050 ST	2050 HT	2050 ET	2050 STP		
ANSI TECHNICAL REFERENCE						
NON ANSI DECSCRIPTION	2050-1200	2050-2000	2050-3000	2050-1200		
Dimensions						
Leakage Distance (in)	416	452	414	557		
Height (in)	182	185	182	182		
Max Shed Diameter (in)	9.3	10.7	11.3	10.3		
Top BCD (in)	5	7	5	5		
Diameter Dt (in)	6.2	8.7	6.2	6.2		
Bottom BCD (in)	7	14	14	7		
Diameter Db (in)	8.7	15.7	15.4	8.7		
Mechanical Values						
Cantilever Strength, Upright, Pounds	1200	2000	3000	1200		
Tensile Strength, Pounds	20000	20000	25000	20000		
Torsion Strength, Inch-Pounds	60000	60000	75000	60000		
Compression Strength, Pounds	60000	60000	60000	60000		
Electrical Values						
Impulse Flashover, Positive, kV	2250	2250	2250	2250		
Low Frequency Withstand, 10 Sec. Wet, kV	830	830	830	830		
Impulse Withstand, kV	2050	2050	2050	2050		
Radio Influence Voltage Data						
Test Voltage, Rms to Ground, kV	350	350	350	350		
Maximum RIV, Microvolts at 1000kHz	2000	2000	2000	2000		
Weight						
Approximate Net Weight, Pounds	653	929	1083	728		

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The very Best.

ANSI Post Insulators

Product Index

95kV-2050kV BIL

CATALOG #	ANSI	CANTILEVER	LEAKAGE	PAGE
95 SU	TR 202	2000	10.5	10
95 HU	TR 222	4000	10.5	10
95 EU		8000	10.5	10
110 SU	TR 205	2000	15.5	10
110 HU	TR 225	4000	15.5	10
110 EU		8000	17.0	10
150 SU	TR 208	2000	24.0	11
150 HU	TR 227	4000	24.0	11
150 EU		8000	24.0	11
200 SU	TR 210	2000	37.0	11
200 HU	TR 231	4000	37.0	11
200 EU		8000	37.0	11
250 SU	TR 214	2000	43.0	12
250 HU	TR 267	4000	43.0	12
250 EU		8000	43.0	12
350 SU	TR 216	1500	72.0	12
350 HU	TR 278	3000	72.0	12
350 EU		6000	72.0	12
550 SU	TR 286	1700	99.0	13
550 HU	TR 287	2600	99.0	13
550 EU		5000	95.0	13
550 SUP		1700	125.0	13
550 HUP		2600	125.0	13
550 EUP		5000	120.0	13
650 SU	TR 288	1450	116.0	14
650 HU	TR 289	2200	116.0	14
650 EU		4100	116.0	14
650 SUP		1450	155.0	14
650 HUP		2200	155.0	14
650 EUP		4100	150.0	14
750 SU	TR 291	1200	132.0	15
750 HU	TR 295	1850	132.0	15
750 EU		3500	132.0	15
750 SUP		1200	180.0	15
750 HUP		1850	180.0	15
750 EUP		3500	180.0	15
900 HT	TR 308	1450	170.0	16
900 ET		2750	173.0	16
900 SU	TR 304	950	166.0	16
900 HU	TR 308	1450	173.0	16
900 EU		2750	167.0	16
900 YT		3000	165.0	17
900 ZT		4000	171.0	17
900 SUP		950	227.0	17
900 HTP		1450	229.0	17
900 ETP		2750	228.0	17

CATALOG #	ANSI	CANTILEVER	LEAKAGE	PAGE
1050 ST	TR 312	800	205.0	18
1050 HT	TR 316	1250	204.0	18
1050 ET		2300	206.0	18
1050 SU	TR 312	800	209.0	18
1050 HU	TR 316	1250	207.0	18
1050 EU	TR 362	2300	207.0	18
1050 YT		3500	209.0	19
1050 ZT		5000	317.0	19
1050 STP		800	268.0	19
1050 HTP		1250	271.0	19
1050 ETP		2300	270.0	19
1300 ST	TR 324	1000	241.0	20
1300 HT	TR 367	1450	232.0	20
1300 ET	TR 369	2050	234.0	20
1300 SU	TR 324	1000	242.0	20
1300 HU		1450	244.0	20
1300 EU	TR 368	2050	240.0	20
1300 YT		3000	237.0	21
1300 ZT		4000	233.0	21
1300 STP		1000	326.0	21
1300 HTP		1450	322.0	21
1300 ETP		2050	315.0	21
1470 HT	TR 371	1170	273.0	22
1470 ET	TR 373	1750	274.0	22
1470 HTP		1000	376.0	22
1470 ETP		1750	373.0	22
1470 SU	TR 330	900	272.0	22
1470 EU	TR 372	1750	273.0	22
1550 ST		1000	334.0	23
1550 HT	TR 379	1700	283.0	23
1550 ET		2500	315.0	23
1550 HTP		1700	373.0	23
1800 ST	TR 391	1400	340.0	24
1800 HT		1750	346.0	24
1800 YT		3500	337.0	24
1800 STP		1400	450.0	24
1800 ETP		2500	371.0	24
2050 ST		1200	416.0	25
2050 HT		2000	452.0	25
2050 ET		3000	414.0	25
2050 STP		1200	557.0	25

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PPC INSULATORS

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That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support. **PPC** Insulators quality products and service provide time-tested value to fulfill your needs!
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Hollow Insulators – Custom Design

PPC INSULATORS

The Design Specialist
At Your Service

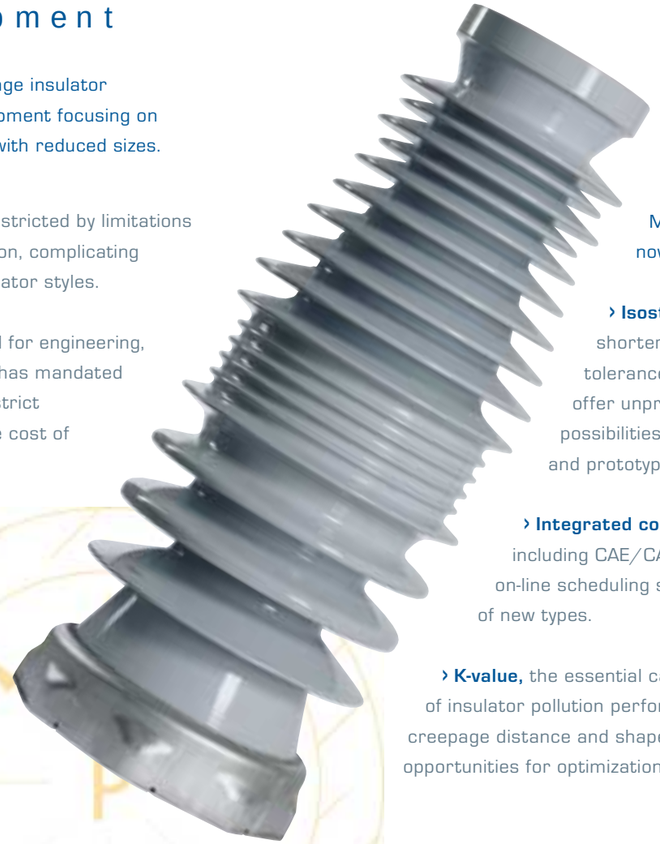
Reduced dimensions
and weight with increased
strength and appearance

New Development

The traditional high voltage insulator
is subject to new development focusing on
improved performance with reduced sizes.

Design has long been restricted by limitations in material and production, complicating introduction of new insulator styles.

Long lead times required for engineering, preparation and tooling has mandated product uniformity and strict recommendations at the cost of function-specific design.



Major improvements
now set new standards.

› **Isostatic** process with shorter lead-times, tighter tolerances and flexible design offer unprecedented possibilities for development and prototype production.

› **Integrated computer systems** including CAE/CAD/CAM and on-line scheduling speeds introduction of new types.

› **K-value,** the essential calculation of insulator pollution performance, consider creepage distance and shape to open new opportunities for optimization.

**We are at your service to develop
custom tailored insulators for your specific requirements!**

› ISO 9001 › IEC

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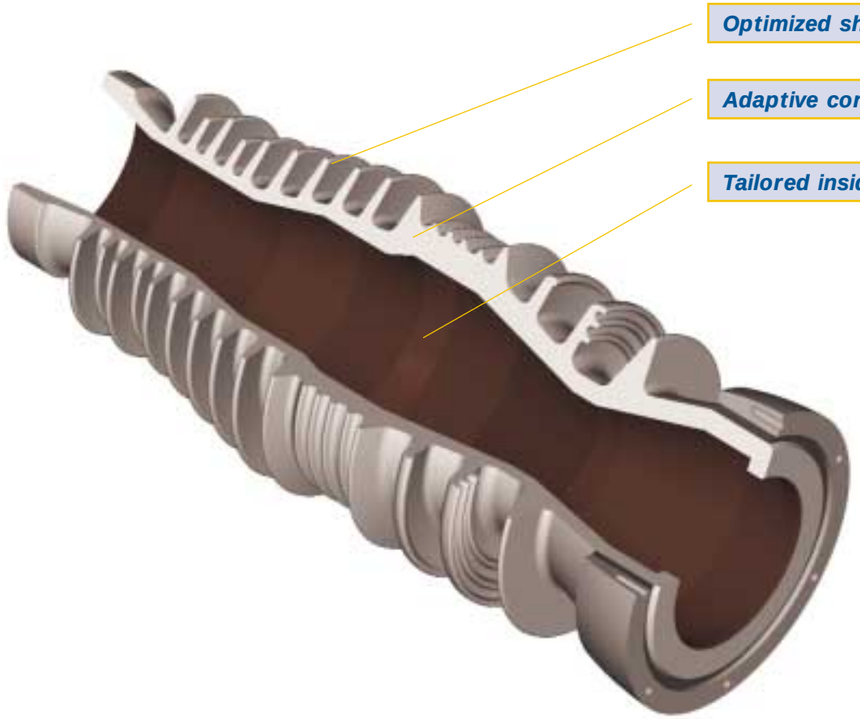
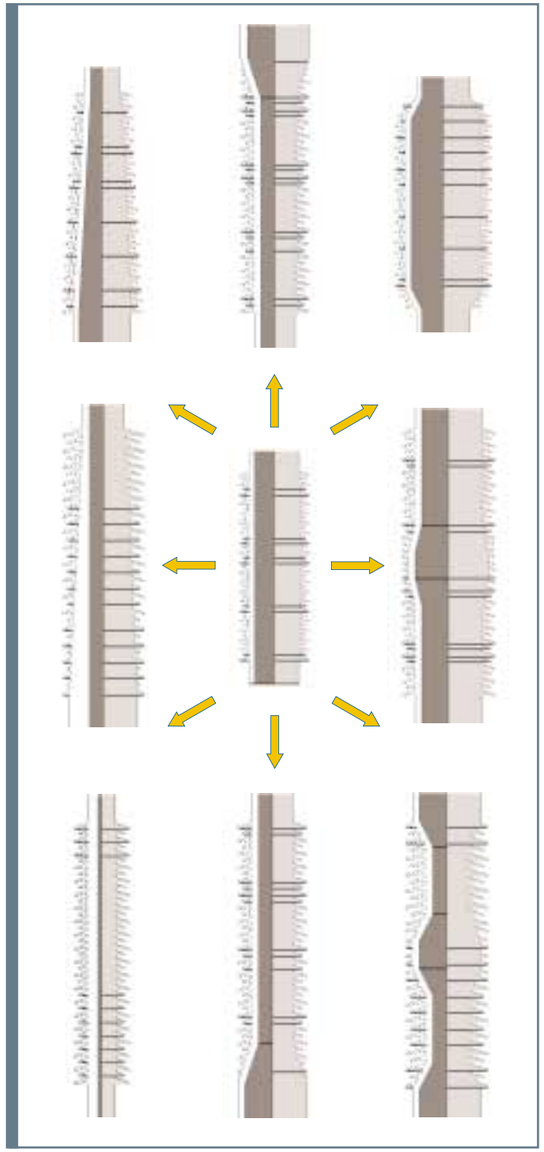
PPC INSULATORS

Hollow Insulators
Introduction

Hollow Insulators
Design and Redesign

Possibilities





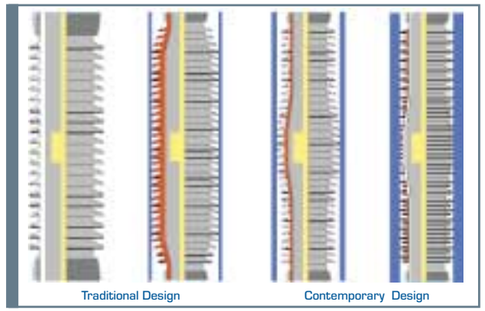
Flexibility

PPC Insulators promote optimized design of all high voltage insulators.

Integration of **CAE/CAD/CAM** systems and advanced production process offer flexibility and development of contemporary insulator design.

Improvements
Increased

- mechanical performance
- electrical performance
- pollution performance
- seismic performance
- visual appearance
- safety



Improvements
Reduced

- number of units and joints
- number of different types
- dimensions and weight
- volume and space
- tolerances
- total cost

Hollow Insulators
K-value

Increased Pollution Performance
Equalized Field Distribution

K-value design is a method to improve traditional creepage distance.

In its full extent, K-value design is a method to reduce
› **weight** › **volume and** › **space**
while improving properties in service by increasing pollution performance and equalizing the electrical field.

IEC 60507

International standard **IEC 60507** define form factor as:

$$F = \int dl / p(l)$$

l is the creepage distance
p(l) is the circumference of the insulator as a function of l.

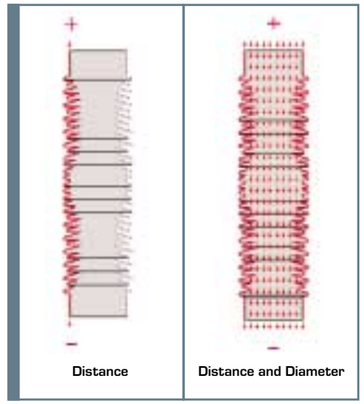
IEC standards and guides	
IEC 60507 §3.4	Form factor of an insulator
IEC 60507 §16.1	Layer conductivity
IEC 60815 §5.3	Influence of the diameter
IEEE DEIS publications	
CEIDP 1998, 2A-6	Development trends ...
CEIDP 2000, 3A-10	Optimized design ...
Patent	
SE 9700508-6	Insulator with equalized field strength

K-value Design

Form factor used as a design method is referred to as K-value and can be used for different improvements.

Creepage distance considers a leakage current as traveling along the exterior contour of the insulator, identifying only the linear distance.

K-value considers a leakage current as traveling along the insulator over its surface. K-value identifies an insulator's total shape, i.e., geometric (ohmic) resistance against leakage currents. It is necessary to calculate the shape of the surface of the insulator for reaching optimum pollution performance.



Traditional calculation of creepage distance is still used, but to achieve best performance in relation to material and space used, K-value design is essential.

PPC Insulators offers complete computer design of K-value, integrated with traditional requirements.

Basic Example

Average diameter is reduced while creepage distance and total height is unchanged.

Results

1. Reduced weight and volume.

2. Increased surface resistance against leakage currents therefore improved performace of creepage distance.

Progressive Example

Average diameter is reduced while creepage distance and total height is unchanged. Creepage distance concentration along the insulator is adapted to counterbalance the surface resistance against the electrical field from inside and outside equipment.

Results

1. Reduced weight and volume.

2. Increased surface resistance against leakage curents, thereby improving performance of the creepage distance.

3. Improved service performance and pollution properties by equalizing the electrical field.

Dimensions

Dimensional values are general and may vary according to design. Many parameters must be considered, as ratio between height and core diameter, weight and wall thickness, and different inner diameters. Dimensions are continuously subject to improvements.

Height Single Porcelain	Height Jointed Porcelain	Outside Diameter
2800 mm	8500 mm	950 mm
110.2 inches	334.6 inches	37.4 inches

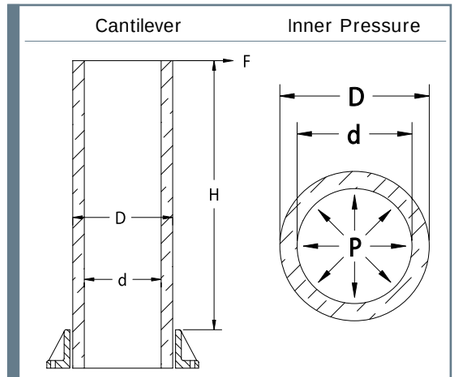
Standards

Standards	
Material	IEC 60672
Dimensions, form, position	IEC 60233
Tests	IEC 60233 IEC 61264 IEC 62155
Many other standards and customer specifications are considered on request.	

Material and Specific Strength

The mechanical strength of an insulator depends on different parameters.

› **Material strength**
› **Design**
› **Material and design of fixing and fitting arrangement**



$$\sigma = \frac{F * H}{Wx} \qquad \sigma = L * P$$

$$Wx = \frac{\pi}{32} * \frac{D^4 - d^4}{D} \qquad L = \frac{D^2 + d^2}{D^2 - d^2}$$

Material properties meet specifications stated in IEC publication 60672.

Typical values of specific strength for complete insulator with traditional design are given by basic formula and in the table below. Optimizing design can often increase strength.

Material IEC 60672	C 110	C 120	C 130
Strength	**MPa psi**	**MPa psi**	**MPa psi**
Cantilever Flange	18 2620	30-45 4350-6525	50-70 7250-10150
Cantilever Clamp	17 2465	22 3190	40 5800
Cantilever Core	25 3625	30-45 4350-6525	50-70 7250-10150
Cantilever Epoxy Joint	25 3625	25 3625	25 3625
Inner Pressure	17 2465	25-30 3625-4350	30-45 4350-6525

Hollow Insulator Design Criteria

The design of the insulator will mostly depend on mechanical requirements determined by the equipment manufacturer in relation with apparatus design.

The main parameters are:

Design pressure. The difference between maximum absolute pressure when the equipment is carrying its rated normal current at maximum ambient temperature and outside pressure.
In special cases, as for circuit breakers, the transient pressure rise that occurs during breaker operation must also be taken into account.

Type test withstand bending moment.
A combination of the different loads, which may occur under service conditions.

Dimensions of the apparatus.

Environmental conditions on site
(creepage distance, shed design and form factor)

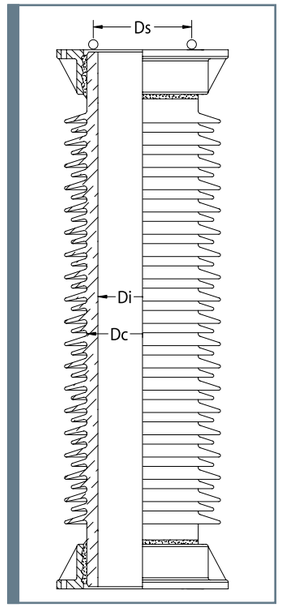
Determination of Type Test Withstand Bending Moment

Factors that may contribute to the bending stress that may occur in electrical equipment are mass, internal pressure, terminal, short-circuit, ice, wind and seismic load. See table.

Stress	From routinely expected loads	From rarely occuring extreme loads		
		Alt 1	Alt 2	Alt 3
Loads		**Short circuit load**	**Ice load**	**Seismic load**
Design pressure	100%	100%	100%	100%
Mass	100%	100%	100%	100%
Rated terminal load	100%	50%	0%	70%
Wind pressure	30%	100%	0%	10%
Short circuit load	0%	100%	0%	0%
Ice load	0%	0%	100%	0%
Seismic load	0%	0%	0%	100%
Safety factor f	2.1	1.2	1.2	1.0

The following sources should be used for determining the values necessary for calculating the relevant loads:

Terminal loads	IEC 56	§ 6.101.6.1
Wind loads	IEC 56	§ 6.101.6.1
	IEC 694	§ 2.1.2
Ice loads	IEC 56	§ 6.101.6.1
	IEC 694	§ 2.1.2
Short circuit loads should be determined from the rated level of the equipment		
Seismic loads	IEC 56 (17A [sec] 274)	



The alternative combinations are typical sets of loads for particular equipment for specific applications.
The most onerous of the applicable alternatives should be used to determine the test withstand bending stress.

From the test withstand bending stress, the test withstand bending moment can be calculated.

$$Mb = P * \frac{\pi}{32} * \frac{D_s^2(D_c^2+D_i^2)}{D}$$

P = Design pressure
Ds = Sealing diameter
Dc = Core diameter
Di = Inside diameter

The simplified calculation is valid under this condition:

$\sigma_a \leq 0.25 * \sigma_b$ where: $\sigma_a = P * \frac{D_s^2}{D_c^2+D_i^2}$ Corresponds to the axial stress due to pressure P.

$\sigma_b = M_{max} \frac{\pi}{32} * \frac{D_c}{D_c^4-D_i^4}$ Corresponds to the axial stress due to the maximum permanent bending moment in service.

Bending Moment

Relation between testing values and utilization values for a hollow insulator

Testing Values		Utilization Values	
Type test withstand	100%	$\frac{100}{1.0}$ =100%	Alt 3 (rarely)
		$\frac{100}{1.2}$ = 83.3%	Alt 1 Alt 2 (extreme)
Routine Test	70%		
		$\frac{100}{1.2}$ = 47.6%	(routinely)

Example of hollow insulator:

σ_a = 1.625 MPa
σ_b = 10.62 MPa
=> $\sigma_a \leq 0.25 * \sigma_b$
M_{max} = 20kNm

Dimensions	Bending Moments	
Dc = 300mm	Mass	10 kNm
Di = 220mm	Rated terminal load	10 kNm
Ds = 260 mm	Wind pressure	10 kNm
	Short circuit load	10 kNm
	Ice load	10 kNm
	Seismic load	10 kNm
	Inner Pressure Design value	1 MPa

The bending moment can hereafter be calculated equivalent to the design pressure Mb ≈ 3 kNm.

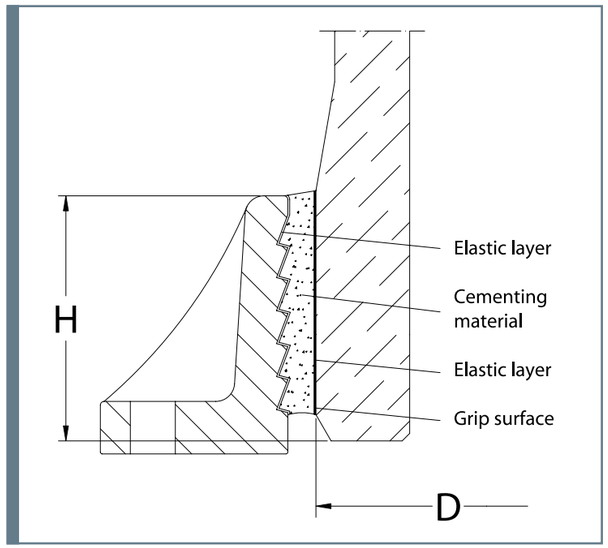
Determination of Type Test Withstand Design Pressure

The insulator shall withstand 4.25 times the design pressure for 5 minutes.

Hollow Insulator Design Criteria

Influence of Fitting and Clamping Design

The method and dimension of fixing arrangement is most important for the structural strength of the insulator. Cemented fittings and flanges generally offer maximum strength. As an alternative, it is also possible to use clamping devices.



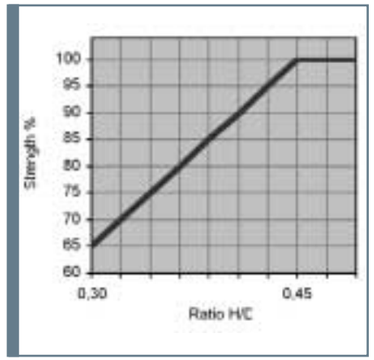
The relation between height of fitting (H) and diameter of porcelain (D) is important.

Elastic layer on metal part is an epoxy or a bituminous paint. On porcelain this layer is bituminous paint.

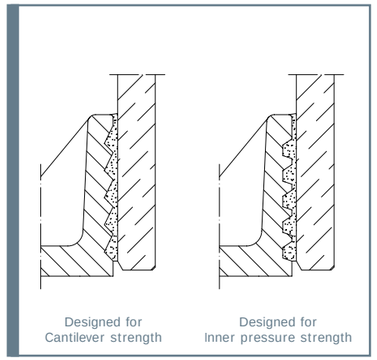
Cement is Portland or sulphur.

Grip surface is comprised of porcelain grains embedded in glaze and/or glazed grooves in porcelain.

Influence of Fitting High and Cantilever Strength

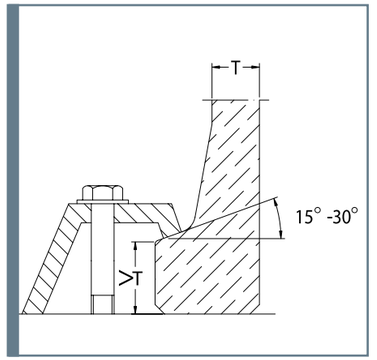


Influence of Internal Grooves



Internal grooves can be designed to distribute stress for different strength configurations.

Influence of Clamp and Fixing



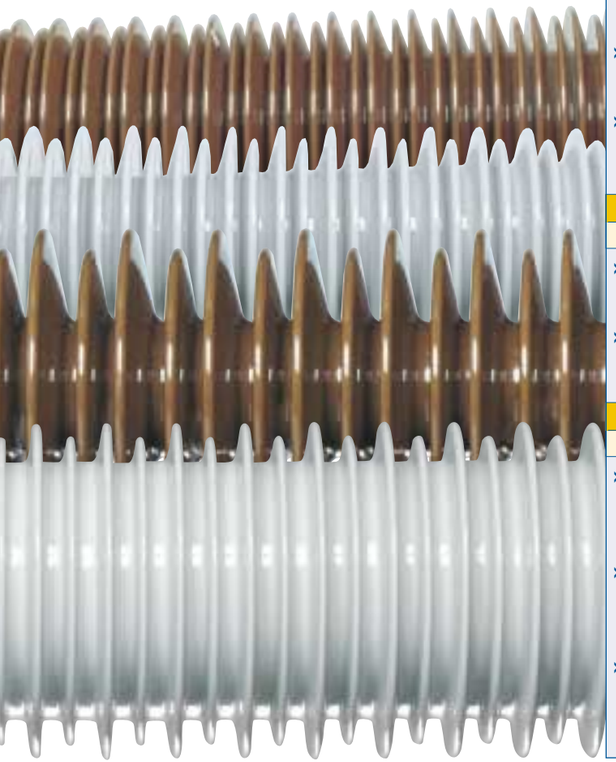
A smooth design with tapered adaptation between clamp and wall is recommended for best performance.

The fixing lugs require the forces from the clamping jaws to be evenly distributed and that the grip is very firm. It is essential that the clamping arrangement is not allowed to bend bakwards.

Hollow Insulators
Pollution Performance

Pollution Levels

Guidance on design and selection of creepage distance with respect to environmental conditions can be found in IEC recommendation 60815.
Basic levels of pollution are qualitatively defined with examples of typical environment situations.
Corresponding minimum nominal creepage distance is given in mm/kV.



Level	Pollution	Specific Creepage Distance	
1	Light	16 mm/kV	0.630 inch/kV

› Areas without industry and with low housing density equipped with heating plants.

› Areas with low density of industry or houses but subjected to frequent winds and/or rainfall.

› Agricultural areas.

› Mountainous areas.

Level	Pollution	Specific Creepage Distance	
2	Medium	20 mm/kV	0.787 inch/kV

› Industrial areas not producing particulate polluting smoke and/or with average housing density equipped with heating plants.

› Areas with high density of houses and/or industry but subjected to frequent winds and/or rainfall.

› Areas exposed to wind from the sea but not too close to the coast (at least several kilometers distant).

Level	Pollution	Specific Creepage Distance	
3	Heavy	25 mm/kV	0.984 inch/kV

› Areas with high density of industries and suburbs of large cities with high density of heating plants producing pollution.

› Areas close to the sea in any case exposed to relatively strong winds from the sea.

Level	Pollution	Specific Creepage Distance	
4	Very Heavy	31 mm/kV	1.220 inch/kV

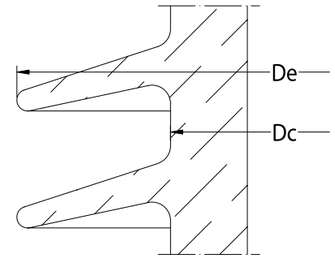
› Areas generally of moderate extent, subjected to conductive dusts and to industrial smoke producing particularly thick conductive deposits.

› Areas generally of moderate extent, very close to the coast and exposed to sea-spray or to very strong and polluting winds from the sea.

› Desert areas, characterized by no rain for long periods, exposed to strong winds carrying sand and salt, and subjected to regular condensation.

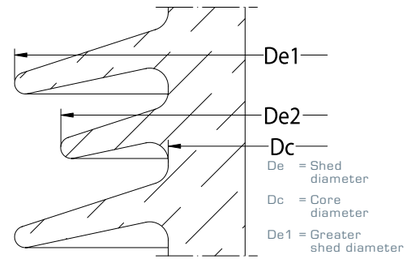
Regular sheds

$D_m = (De+Dc)/2$



Alternating sheds

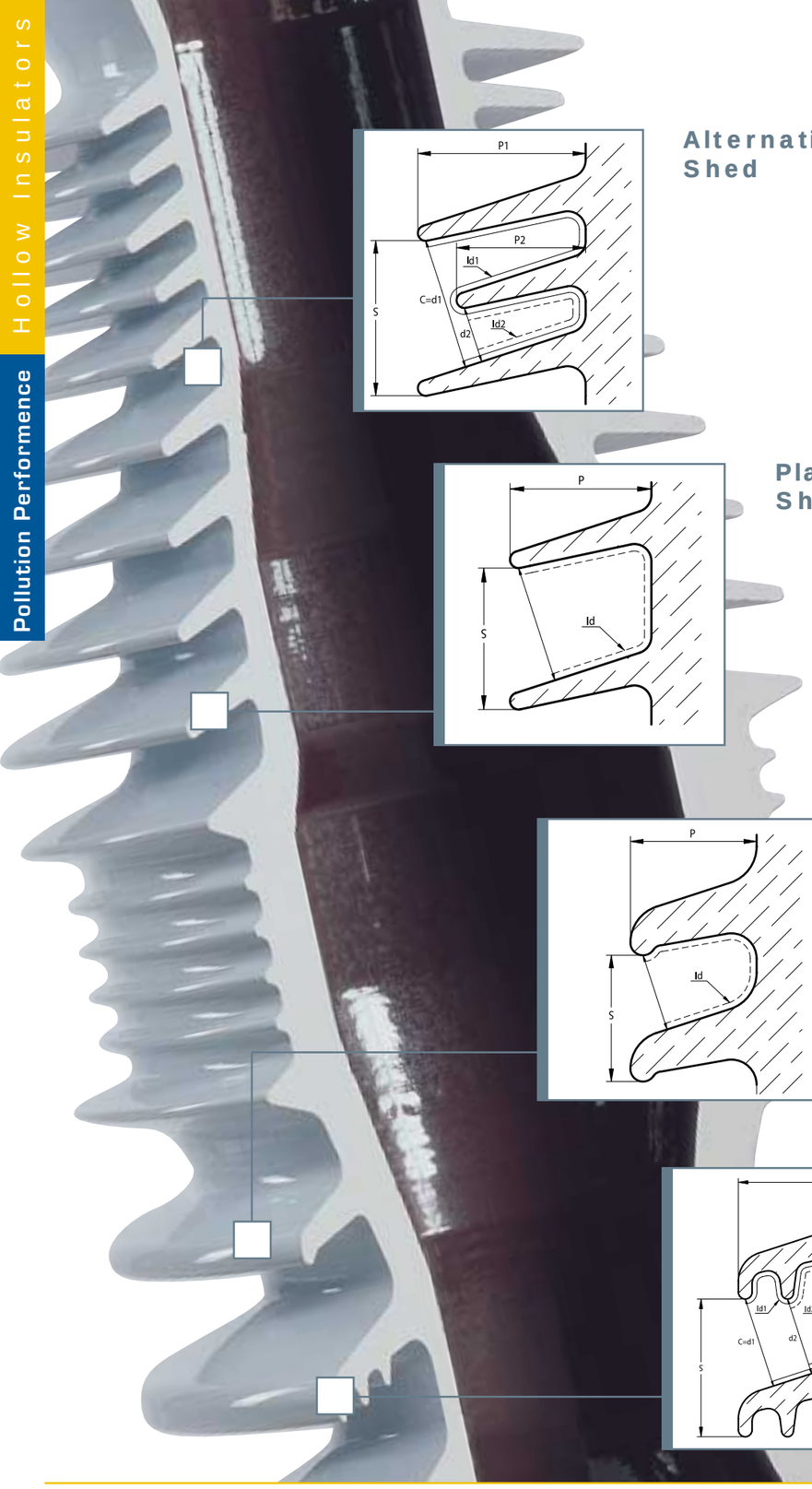
$D_m = (De1+De2+(2*Dc))/4$



De = Shed diameter
Dc = Core diameter
De1 = Greater shed diameter
De2 = Smaller shed diameter

The creepage distance should be increased in relation to the average diameter, D_m.

D_m <300 mm	k_d = 1.0
D_m 300-500 mm	k_d = 1.1
D_m >500 mm	k_d = 1.2



Alternating Shed

Plain Shed

Standard (traditional) Shed

Under rib Shed

Hollow Insulators
Pollution Performance

Shed Design

The plain alternative shed design offers high specific creepage distance together with good self-cleaning properties and usually provides best performance. Using flexible shed design can optimize most insulators.

Parameters Characterizing Insulator Profile

1. Minimum distance, c, between sheds

- Generally c ≥ 30 mm.
- For small insulators (H < 550 mm) or overhang (p ≤ 40 mm), c can be ≥ 20 mm.

2. Ratio s/p between spacing and overhang

- Sheds without under ribs ≥ 0.65.
- Sheds with under ribs ≥ 0.8.

3. Ratio l_d/d between creepage distance and clearance

- This ratio must be calculated for the "worst case" on any section ($l_{d1}/d1$, l_{d2}/d_2).
- It must be < 5.

4. Alternating shed

- $p_1 - p_2 \geq 15$ mm

Parameters Characterizing Entire Insulator

1. Creepage factor C.F.

$$C.F. = lt / St$$

lt= creepage distance
St= arcing distance

- C.F. ≤ 3.5 for pollution levels 1 and 2.
- C.F. ≤ 4 for pollution levels 3 and 4.

2. Profile factor P.F.

$$P.F. = \frac{2p1 + 2p2 + s}{l}$$ alternating sheds

$$P.F. = \frac{2p + s}{l}$$ all other sheds

l = creepage distance of the insulated leakage path measured between the two points which define s.

- P.F. > 0.8 for pollution levels 1 and 2.
- C.F. > 0.7 for pollution levels 3 and 4.

Hollow Insulators
Tolerances

General Tolerances

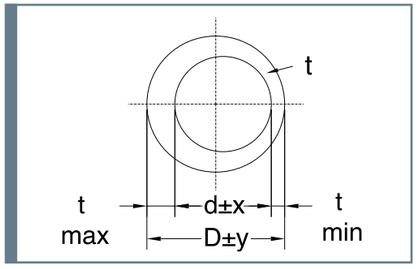
The tolerances in dimensions depend mostly on production process.
General tolerances given may be improved by design and repeated production.

Plastic process	**± (0.04 d + 1.5 mm)** when d ≤ 300 mm
	± (0.025 d + 6 mm) when d > 300 mm
Dry process	**± 3** %
Isostatic process	**± 1.5** % (+ 1 mm)

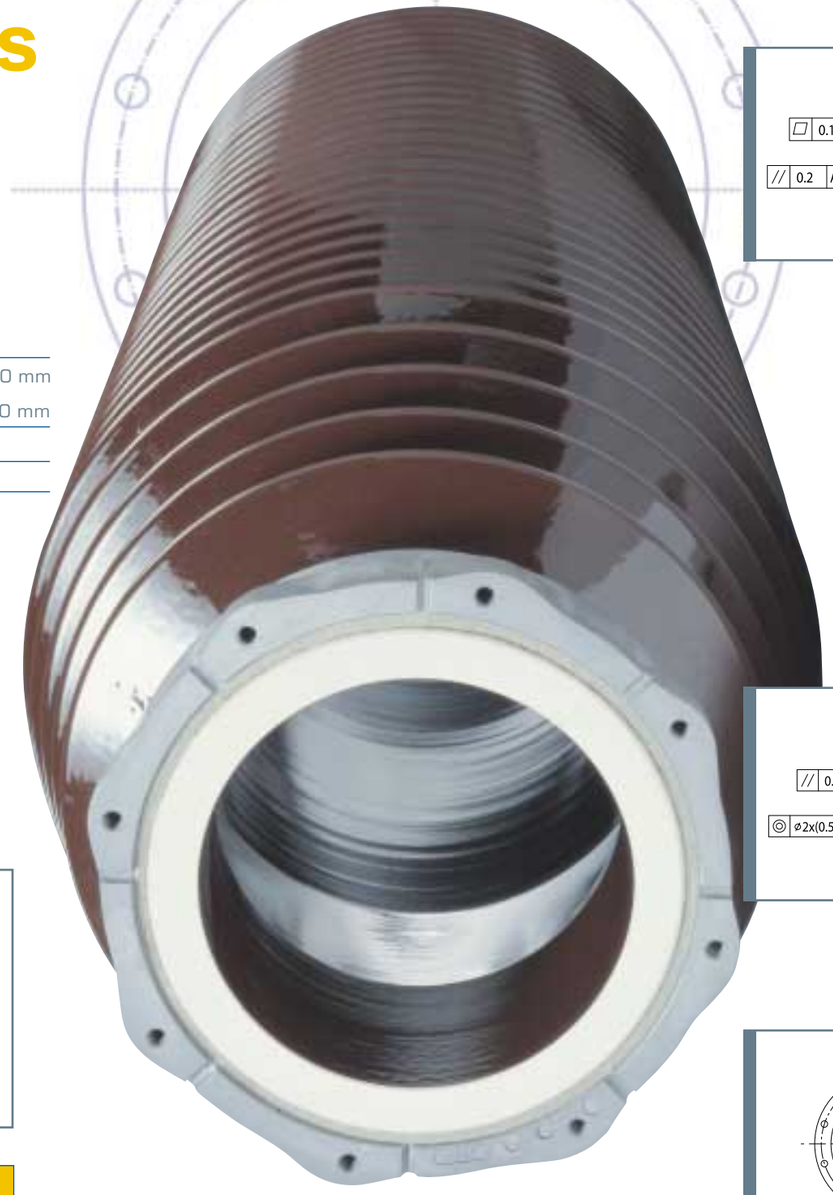
Deviation from Roundness

The deviation from roundness is included in the general tolerances.

Tolerance of Wall Thickness



Wall thickness (mm)	Tolerance (mm)
< 10	+ a / -1.5
10-15	+ a / -2.0
15-20	+ a / -3.0
20-25	+ a / -3.5
25-30	+ a / -4.0
30-40	+ a / -4.5
40-55	+ a / -5.0
> 55	+ a / -6.0

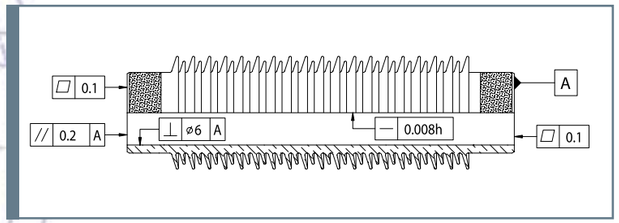


$$a = \frac{x + y}{2}$$

x = tolerance on inner diameter
y = tolerance on core diameter

Tolerances of Form and Position

Unassembled porcelain



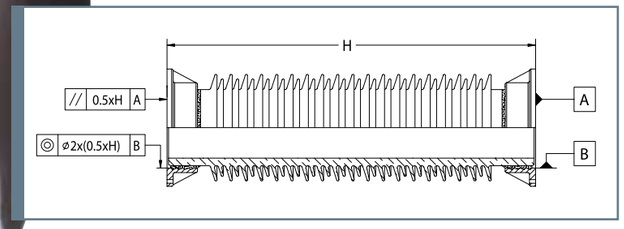
Evenness
The numerical value indicates the maximum admissible surface deviation.
0.10 mm standard tolerance
0.03 mm can be achieved on request

Perpendicularity
The axis of the insulator has to be within the indicated value of the diameter of a cylinder, which is perpendicular to plane face A.
6 mm standard tolerance
4 mm can be achieved on request

Camber
The centerline should be within a cylinder with the diameter equal to the tolerance times the length of the porcelain.
0.8 % x height of porcelain + 1.5 mm

Plane parallelity
The upper plane face is parallel to the lower reference plane A within indicated tolerance.
0.2 mm

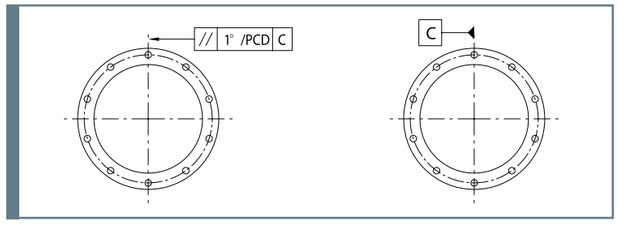
Assembled porcelain



Coaxiality and concentricity
The centerline of the pitch circle diameter of the two fittings should fit into a cylinder with diameter equal to
2 x (0.5 + height of insulator in meters) mm

Plane parallelity
0.5 x (height of insulator in meters) mm
0.2 x (height of insulator in meters) mm
(0.2 can only be reached on fittings with machined surface without protection)

Alignment of fixing holes



Alignment of fixing holes
The line between two opposite axes of holes of the top fitting have to be in line with corresponding line of the bottom fitting within the specified angle.
1° standard

Finish of Ground Surface

Classification of roughness	Ra (µm)
General purpose oil tight	6.3
Air tight	3.2
SF6-gas under pressure	1.6

Hollow Insulators
Test and Inspection

Marking

Each insulator is marked both with designation and serial number, making it possible to trace inspection procedures throughout production.

Inspections and Tests

after firing are usually made according to
IEC 60233 and IEC 61264, IEC 62155.

Tests	Type test	Sample test	Routine test
After firing			
Visual inspection			✓
Verification of dimensions		✓	
Porosity test		✓	
Temperature cycle test		✓	
After grinding			
Dimensional inspection of ground parts		✓	✓
Inner pressure test **			✓
Dye check on ground surface **			✓
Electrical routine test *		✓	✓
After cementing			
Bending test **	✓	✓	✓
Inner pressure test **	✓	✓	✓

* Electrical routine test is only performed on request for insulators made in one piece, but as routine test on epoxy jointed insulators.
** Only performed on request.

Metric

Metric multiple units used		
M	mega	$*10^{6}$
k	kilo	$*10^{3}$
m	milli	$*10^{-3}$
µ	micro	$*10^{-6}$

Conversion Table

Dimensions	Force	Moment of Force	Pressure, stress
1 mm	1N	1 Nm	1Pa
0.03937 in	0.22481 ft lb	8.8508 ft lb in	0.14504*10-3 psi
25.4 mm	4.4482N	0.11299 Nm	6.8948*103 Pa
1 in	1 ft lb	1 ft lb in	1 psi

SEVES

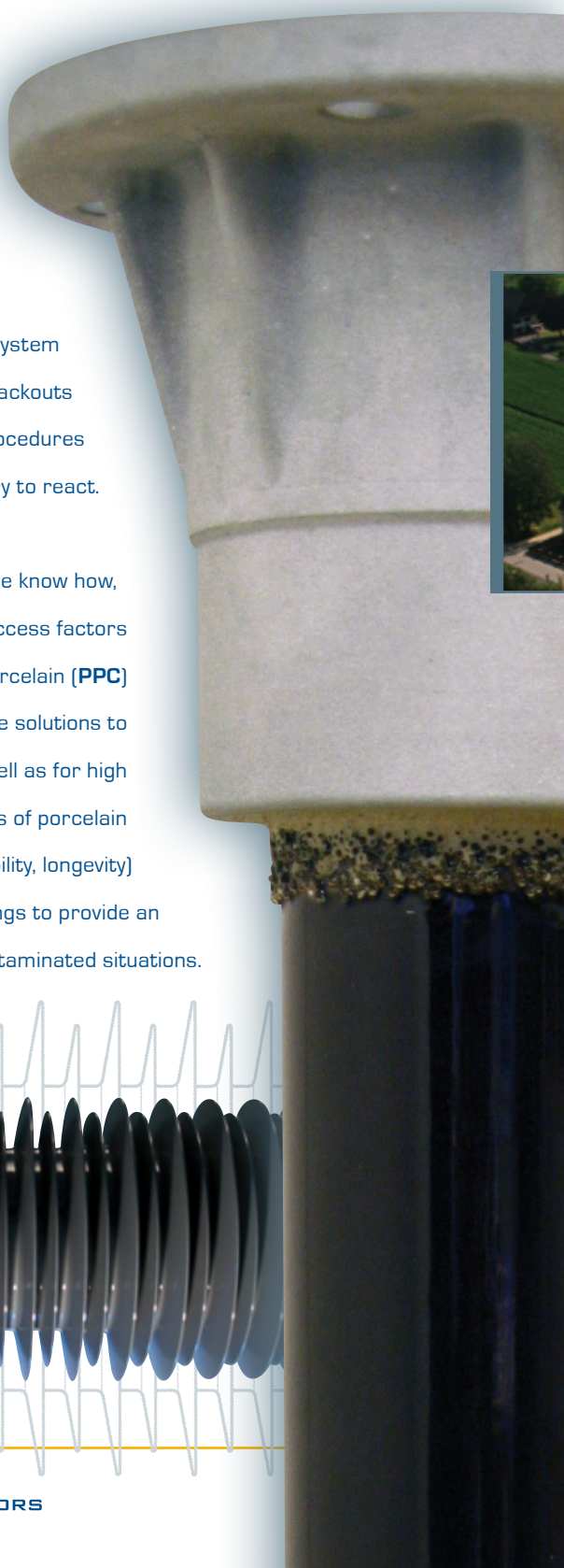
The very Best.

Hybrid Insulators

PPC INSULATORS

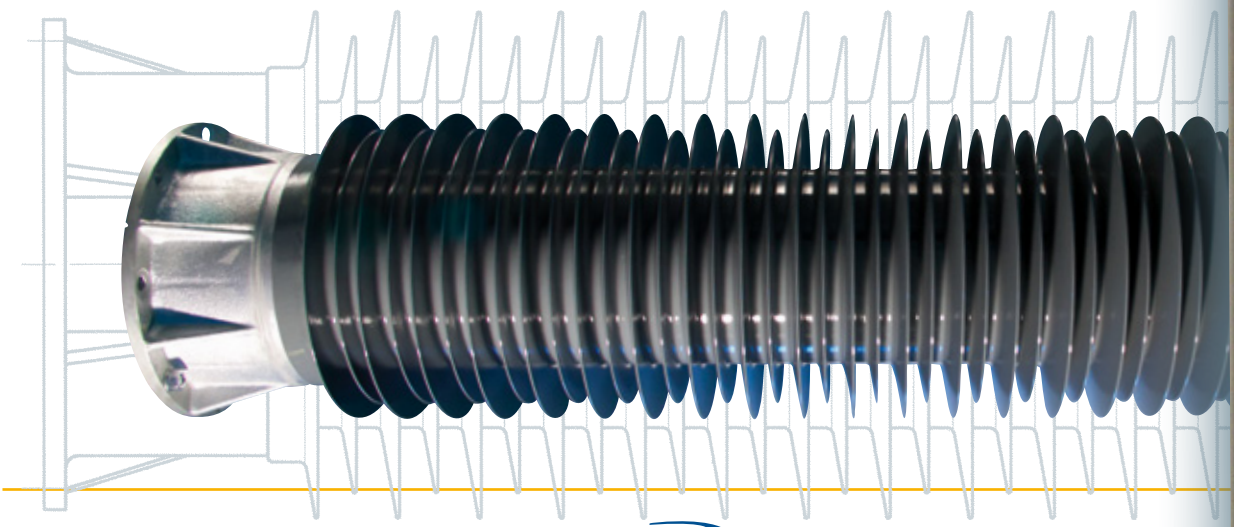
Hybrid Insulators.

Combining PPC and



Extreme environmental or high pollution conditions like those encountered in industrial, desert or coastal regions can lead to electrical activity on insulators involving excessive leakage current. The surface condition of an insulator in such areas can subsequently lead to a pollution flashover and ultimately to power system outages. The need for reliable power networks, avoidance of blackouts and substation shutdowns due to frequent maintenance procedures like substation washing led the insulation Industry to react.

Satisfying our customers is our ultimate goal. Unique know how, constant innovation as well as flexibility are the main key success factors in this fast moving world. **SEVES** long-term expertise in porcelain (**PPC**) and composite (**SEDIVER**) technology allows us to provide alternative solutions to customers for High to Ultra High Voltage AC and DC insulation, as well as for high pollution environments: Hybrid insulators, combine the advantages of porcelain (undisputed superiority of high mechanical strength, stability, longevity) with the excellent performance of composite housings to provide an ideal solution for use in highly contaminated situations.



SEDIVER expertise.

Manufacturing Technology

The conceptual approach of a **PPC** Hybrid Insulator consists of a precisely manufactured porcelain rod onto which a silicone housing is injection molded. The insulators are manufactured entirely in Austria using the extensive **Sediver** expertise for HTV silicone rubber plus **PPC** Insulators know how of Isostatic produced solid core post insulators.

PPC Insulators – Austria

Porcelain Rod

The porcelain core is manufactured with the **PPC** Isostatic process taking advantage of flexible design, tight tolerances and short lead times. Ceramic granulate is pressed into a cylindrical blank at very high pressure. After turning, glazing and firing, the rod is cut to the required length. Hot-dip galvanized fittings made of spheroidal cast iron are then cemented onto the rod.

PROCESS

- Material Preparation
- Blank Pressing & Turning
- Glazing & Firing
- Cutting & Grinding
- Assembling with metal fittings

Silicone Rubber Housing

High pressure injection molding at high temperature is required due to the HTV silicone rubbers high viscosity. Injection molding technology used by **SEVES** is set at temperatures above 160°C and a pressure of several hundred bars.
The silicone housing is fully bonded to the porcelain solid core, perfectly managing the „triple point" (fitting-rubber-core). Thanks to the high pressure involved in this operation, the rubber housing adheres directly to the fitting without the need for artificial sealing.

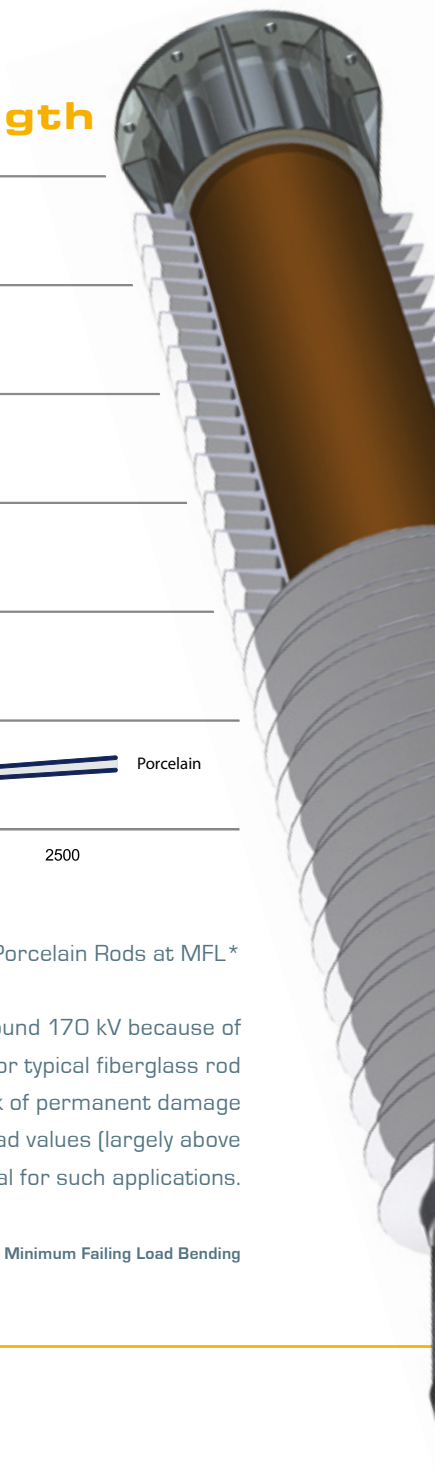
PROCESS

- Surface preparation
- Silicone injection molding
- Insulator Testing

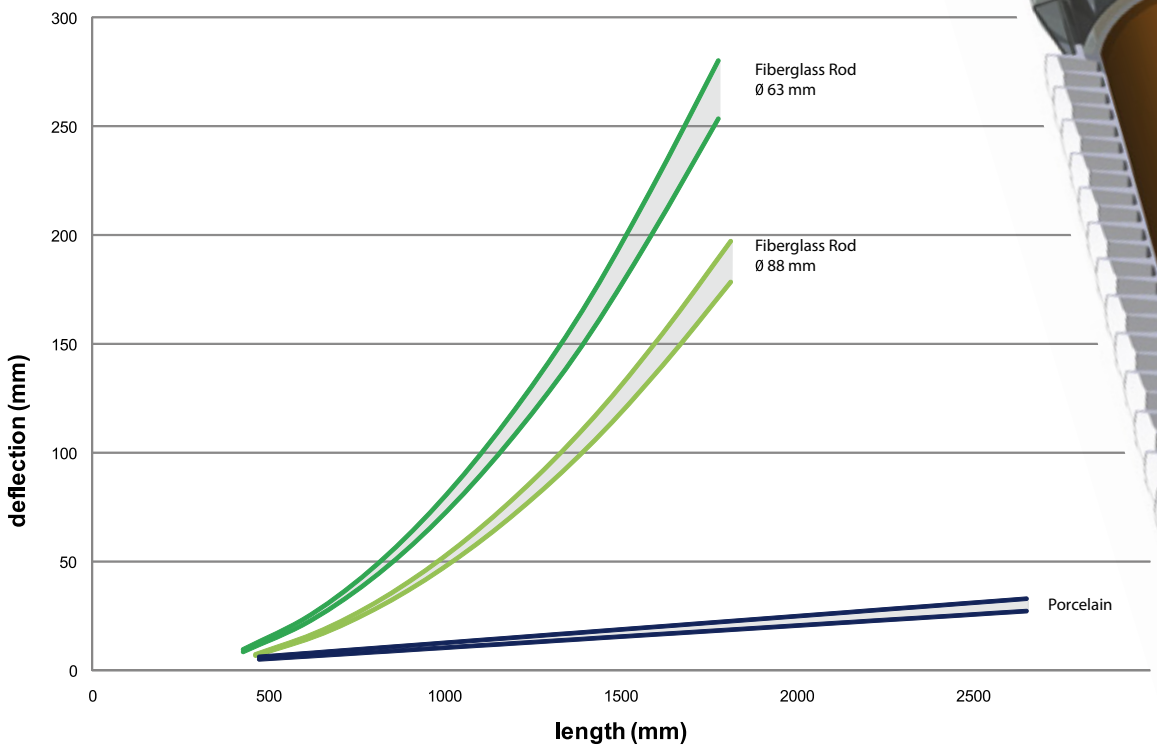
Porcelain strength meets

Porcelain Rod Rigidity

PPC Hybrid Insulators take advantage of our high mechanical strength porcelain rod, offering unique stability along with long time performance. The porcelain core is made of high-strength aluminum oxide porcelain, C130 according to IEC 60672, avoiding material aging and electro corrosion problems of the insulator rod.



Deflection vs. Insulator Length



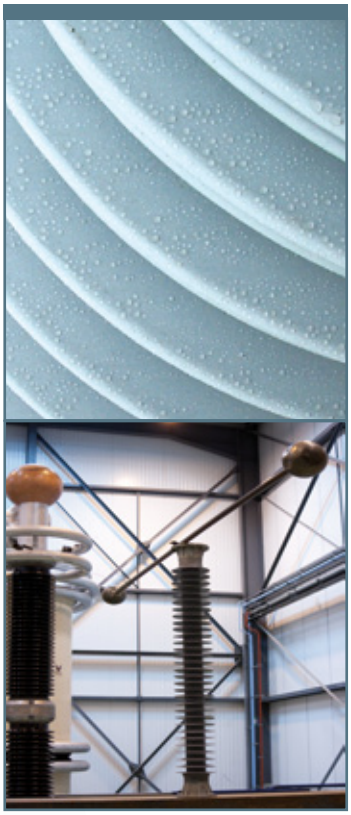
Comparison: Fiberglass Rods at MDCL & Porcelain Rods at MFL*

Polymer solid rod station posts are limited in their application to voltage classes around 170 kV because of excessive deflection values as the length increases. The graph above shows deflection values for typical fiberglass rod diameters used for polymer station post insulators at their MDCL value, above which there is a risk of permanent damage of the core. In comparison, the low value of deflection of porcelain cores at minimum failing load values (largely above the MDCL equivalent load) clearly explains why porcelain cores are ideal for such applications.

*MDCL = Max. Design Cantilever load; MFL = Minimum Failing Load Bending

Hybrid Insulators.

hydrophobicity.

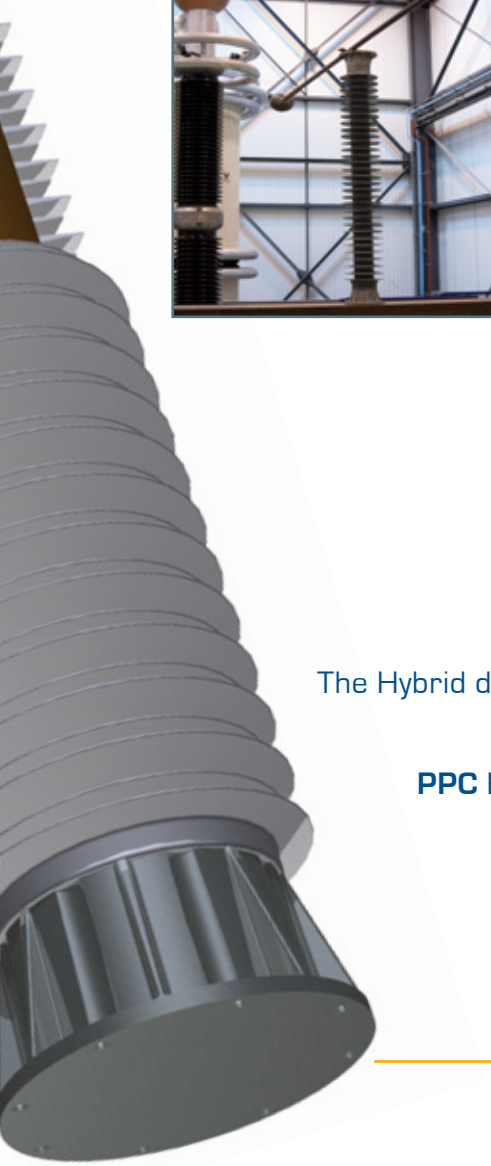


Composite Pollution Performance

Hydrophobicity is widely considered to be the most important factor regarding the insulation behavior of composite insulators. It is well known that under specific pollution events, the hydrophobic property of silicone rubber can be temporarily inhibited. Such conditions will then lead to leakage current formation on the surface of the rubber housing material with the subsequent initiation of possible erosion of the housing itself.

To prevent permanent degradation, high performance silicone rubbers have been designed with specific additives (fillers) to protect the rubber from erosion under these circumstances. These fillers – typically ATH (Alumina Tri Hydrate) fillers – have to be incorporated in the polymer in specific minimum quantities in order to be effective.

The silicone compounds used by **SEVES** are the result of more than 30 years of composite activity in **SEDIVER**. The R&D facility based in St Yorre, France has all the required resources and equipments to achieve the best and most effective product. Tracking wheel test, inclined plan test, 1000 H salt fog test, 5000 h multistress test, are among the necessary steps in the selection of the most appropriate solution.



The Hybrid design offered by **SEVES** uses a specific and superior silicone compound in which the formulation involves an ATH level at least 45% in weight. **PPC** Hybrid Insulator sheds are characterized by an aerodynamic profile, fully complying with IEC 60815.

Hybrid

Best insulation in

Technology

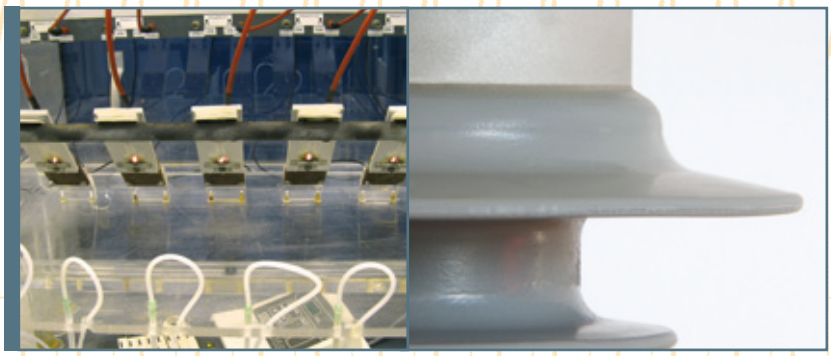
Deflection under Bending Load Performance
Torsion Strength
Compression Strength
Product Lifetime
Pollution Performance
Weight
Vandalism
Maintenance
Reliability

Erosion

Experience and laboratory tests have shown that silicone polymer can suffer severe erosion damage under electrical activity resulting from a partial loss of hydrophobicity. In this respect, it is well-documented that Silicone Rubber enriched with ATH-fillers outperforms silicone rubber with low viscosity such as Liquid Silicone Rubbers (LSR).

Insulator Aging

Inclined Plan Testing



Impenetrabel design:
silicone fully bonded to the fitting

Tracking

To avoid internal tracking, the silicone needs to be fully bonded to the core. Managing the interface of fitting, porcelain core and silicone rubber is critical („triple point"). Benefiting from more than 30 years of experience, the hybrid technology has inherited the unique attribute of the **SEDIVER** impenetrable design. The silicone rubber housing adheres directly to the fitting and the cementing section without the need for artificial sealing.

Insulators.

extreme environments.

Benchmark

porcelain	RTV coated porcelain	Composite	Hybrid
++	++	-	++
++	++	-	++
++	++	-	++
+	-	-	+
-	++	++	++
-	-	++	+
-	-	+	+
-	-	+	+
+	+	-	+

Hybrid Insulators using a porcelain rod are the right technical solution for highly contaminated and polluted areas. Further, deflection under bending load can be a major problem when using composite posts, but the deflection in Hybrid Insulators is extremely limited due to the high mechanical strength of the ceramic cores.

The Hybrid immunity to adverse external conditions is simply outstanding. The nature of the rubber housing will prevent shed breakage resulting from surrounding mechanical shocks. On the other hand, if for any reason the rubber housing is damaged, the porcelain core does not suffer any of the risks associated with exposed fiberglass rods as used in traditional composite insulators.

Maintenance cost of the Hybrid Insulator is reduced to a minimum thanks to the reduced washing required by the HTV silicone given its excellent pollution performance. Flexibility in designing rod dimensions and creepage distances of **PPC** Hybrid Insulators guarantee full substitution of installed porcelain insulators for all substation applications.

PPC Hybrid Insulators are fully compliant with the requirements of IEC 62217, 60587, 62231, 60168 and 60273.

Buying **PPC** Hybrid insulators goes beyond "buying hydrophobicity". Our unique design combines the superior mechanical strength of the porcelain core with a strong housing protection. The HTV silicone rubber selected by **SEVES** provides excellent tracking and erosion performance proven by decades of field performance, thus ensuring the best performance for long term applications.

www.sevespower.com

SEVES

The very Best.

That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support. **PPC** Insulators quality products and service provide time-tested value to fulfill your needs!

Please visit us on the web at www.sevespower.com

PPC INSULATORS

Revision 1/2011

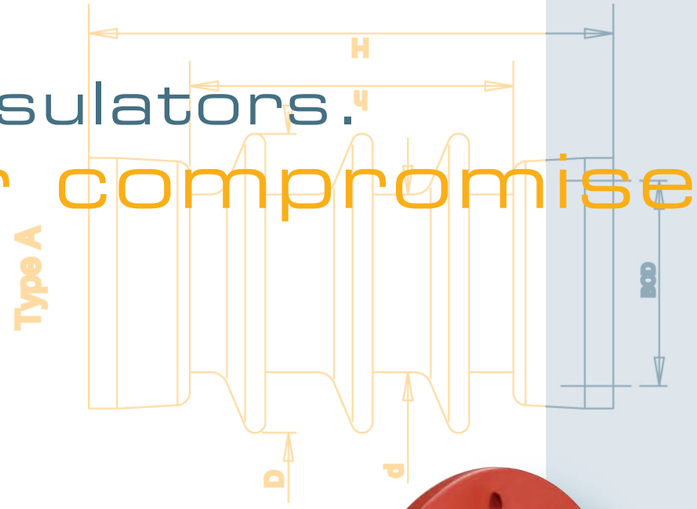
The very Best.

Precipitator Insulators

PPC INSULATORS

Precipitator Insulators.

Never compromise on performance!



PPC, through its wholly owned subsidiary Ifö Ceramics, has long experience in manufacturing a wide range of precipitator insulators. Our manufacturing tradition goes back more than a hundred years.

PPC Insulators

PPC is a world leader and innovator in the manufacture of precipitator insulators for use in electrostatic precipitation technology and applications. From our extensive manufacturing base in northern and Continental Europe, products are designed, engineered and manufactured to meet, and frequently surpass, exacting demands from OEM and industry customers in many applications and geographic areas.

The evolutionary approach to product development, manufacture and design will help **PPC** maintain its long-term competitive position in the industry.

More than 100 years of experience

Since 1918 high tension insulators have been produced at the Bromölla plant in southern Sweden. It was at Bromölla that the cold isostatic production technique was developed and here, in 1988, the company commissioned the worlds first cold Isostatic line of its kind. More than forty years ago, Ifö developed a proprietary ceramic body. The LD-body was developed especially for heavy duty performance in demanding operating environments such as high temperature electrostatic precipitators. Over the last two decades this design and materials formula, used in precipitator insulators, has given Ifö distinct technical advantages when compared with alternative materials and products.

Precipitator Insulators
for electrostatic applications.

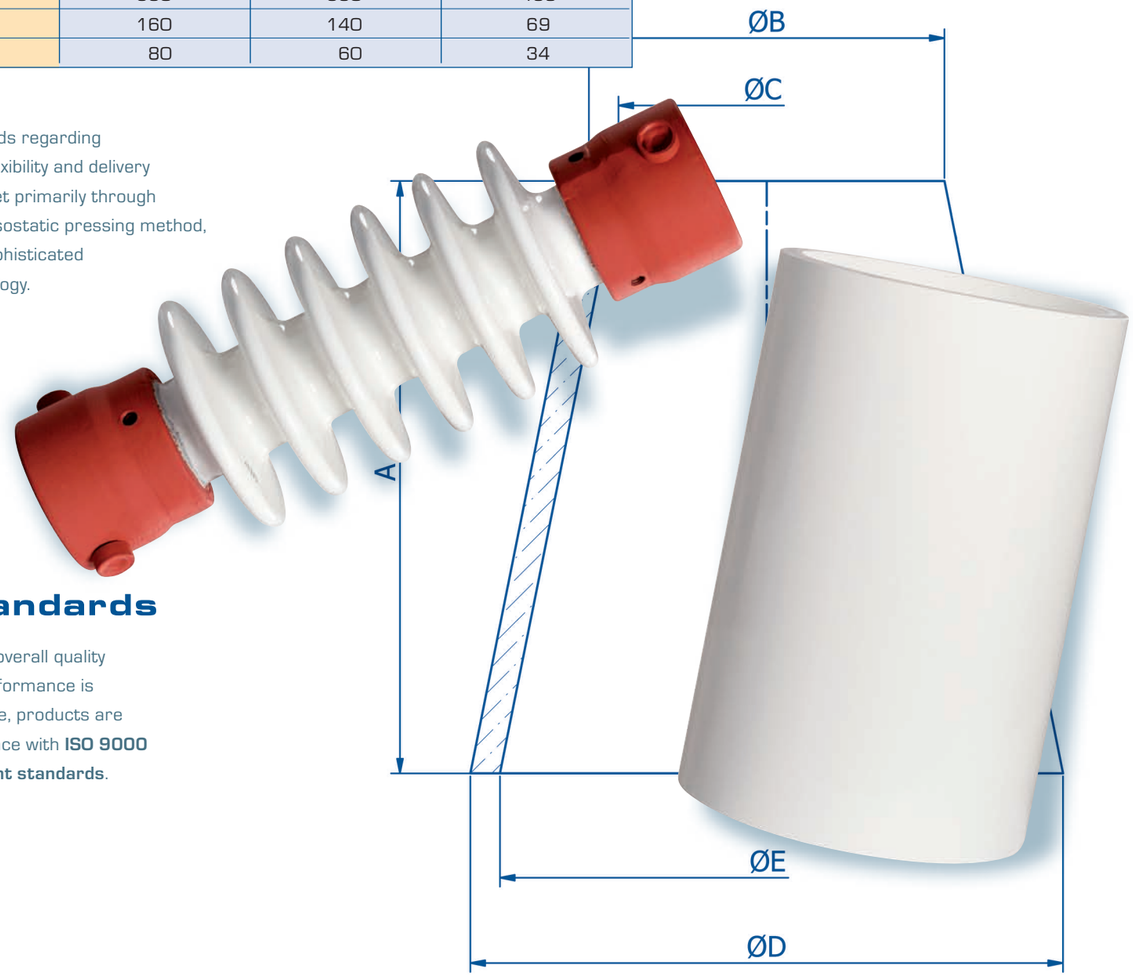
Mechanical strength properties

based on different body materials (comparison in MPa)

Mechanical strength area	LD Ceramics GLAZED	LD Ceramics UNGLAZED	Electrical porcelain
Compressive strength	650	650	458
Flexural strength	160	140	69
Tensile strength	80	60	34

Design

Customer demands regarding product design flexibility and delivery lead times are met primarily through utilizing the cold isostatic pressing method, with the aid of sophisticated comupter technology.



International standards

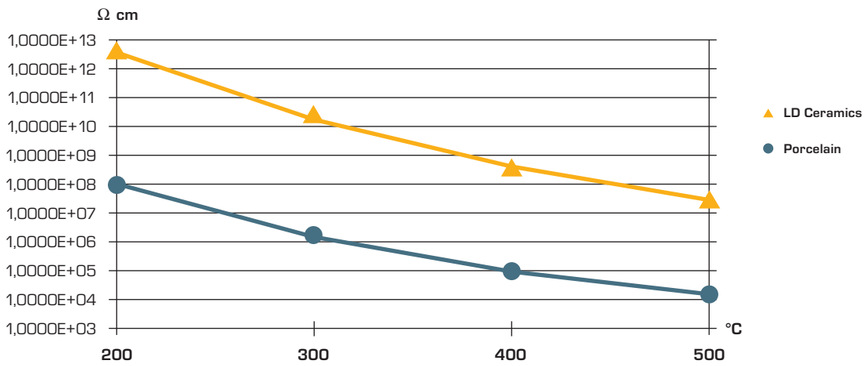
Recognizing that overall quality and technical performance is of vital importance, products are made in accordance with **ISO 9000 and other relevant standards**.

Technical features

LD Ceramics precipitator insulators have a number of outstanding technical features including:

- High DC resistivity at elevated temperatures whereby electrial break-down caused by high leakage current through the material is avoided.
- Excellent mechanical strength and impact resistance, signifcantly reducing failure due to mechanical stress.
- Very low thermal expansion due to increases in temperature or elevated temperature, allowing the insulator to resist cracking in case of thermal shock.
- Glazed surface facilitates visual inspection and cleaning. The glazed surface treatment has a dirt repellent function during plant maintenance and repair work. These properties also significantly reduce the probability of tracking across the material.

Volume resistivity v.s. temperature



Precipitator Insulators.
LD Ceramics for better results.

The benefits of LD Ceramics

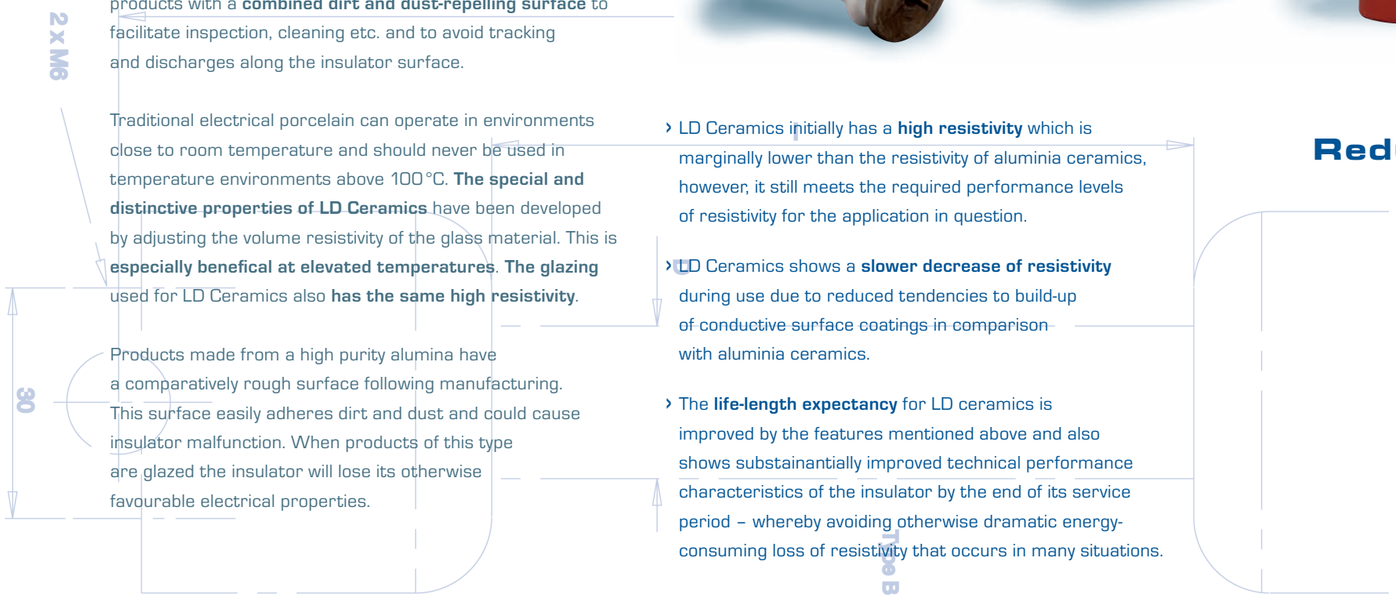
The LD Ceramics body is a high-grade ceramic material with very good mechanical and electrical properties similar to that of aluminia-based electrical porcelain C-120 in accordance with IEC 672.

Precipitator insulators from the LD Ceramics product family typically holds a glass face to approximately 50% of its content. The glass matrix consists of 25% mullit and 20% korund. The glass itself contains 13% of Al_2O_3, making the total content of Al_2O_3 in the body amount to approximately 50%.

They are sintered to a **density degree of 95%** and have **no open porosity** that allows water absorption. Unglazed insulators can thus be used completely safe in various applications. **The glazing** of our precipitator insulators serves the dual enhancement purpose of providing the products with a **combined dirt and dust-repelling surface** to facilitate inspection, cleaning etc. and to avoid tracking and discharges along the insulator surface.

Traditional electrical porcelain can operate in environments close to room temperature and should never be used in temperature environments above 100°C. **The special and distinctive properties of LD Ceramics** have been developed by adjusting the volume resistivity of the glass material. This is **especially benefical at elevated temperatures**. **The glazing** used for LD Ceramics also **has the same high resistivity**.

Products made from a high purity alumina have a comparatively rough surface following manufacturing. This surface easily adheres dirt and dust and could cause insulator malfunction. When products of this type are glazed the insulator will lose its otherwise favourable electrical properties.



- LD Ceramics initially has a **high resistivity** which is marginally lower than the resistivity of aluminia ceramics, however, it still meets the required performance levels of resistivity for the application in question.
- LD Ceramics shows a **slower decrease of resistivity** during use due to reduced tendencies to build-up of conductive surface coatings in comparison with aluminia ceramics.
- The **life-length expectancy** for LD ceramics is improved by the features mentioned above and also shows substainantially improved technical performance characteristics of the insulator by the end of its service period – whereby avoiding otherwise dramatic energy-consuming loss of resistivity that occurs in many situations.

Key data relating to LD material properties

Flexural strength	
for unglazed material	140 MPa
for glazed material	160 MPa
Compression strength	
for unglazed material	650 MPa
for glazed material	650 MPa
Tensile strength	
for unglazed material	60 MPa
for glazed material	80 MPa
Open porosity	nil
Density	2.600 kg/m³
Modulus of elasticity	105 GPa
Linear thermal expansion	
in temperature range 20-200°C	3.3 $K^{-1}x10^{-6}$
in temperature range 20-600°C	4.8 $K^{-1}x10^{-6}$
Thermal conductivity 20-100°C	2.0 w/m°K
Temperature shock resistance	180-200 °K
Dielectric strength	40 kV/mm
Volume resistivity	
at temperature 20°C	10^{18} Ωcm
at temperature 200°C	10^{12} Ωcm
at temperature 400°C	10^{8} Ωcm

Reducing failure and malfunction risks

There are three major causes for operating failure and malfunction of precipitator insulators as described below. By using precipitator insulators from the LD Ceramics product family you can significantly reduce your risk exposure accordingly.

1 Electrical breakdown
resulting from tracking or arcing across the insulator surface. Risks are particularly imminent in ESP start-up situations when the flue gas temperature may be close to the acid dew point and when moisture and dust concentration in the air is high.

2 Electrical breakdown
resulting from high leakage current through the ceramic material itself or its glazing. This is partly due to the rapid temperatue increase that is occuring when high voltage is continously applied over the insulator body.

Consequently, it is imperative to use insulator materials with high resistivity properties at elevated temperatures.

3 Mechanical failure
due to severe mechanical shock or uneven stress distribution through the ceramic material.

www.ppcinsulators.com

IFÖ Ceramics AB
29522 Bromölla
Sweden

The very Best.

That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support. **PPC** Insulators quality products and service provide time-tested value to fulfill your needs!
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The very Best.

Railway Insulators

PPC INSULATORS

Insulators for High Speed Train
Safe traveling

Safe traveling at more than 300 km/h (190 mph)

From the 1930's into the third millennium, we're reducing weight while offering the highest performance.
Since the 1930's, we have manufactured insulators for overhead lines supplying railway networks. Originally, system electrification voltage was 1.5 to 3 kV D.C.

The need for speed from town to town required improvements in the electrification system, thus 15 & 25kV AC voltages were chosen to replace DC. Railway porcelain insulators are subjected to the most severe service conditions, electrical and mechanical stresses, due to parameters of the service site and their performance specifications as required by worldwide railway companies.

PPC Insulators, after more than 70 years of experience in designing and manufacturing railway porcelain insulators, has developed a new concept to improve safety and performance while optimizing cost considerations for our customers.

Our research, in conjunction with national and transnational railway companies, yielded a high-grade design for C130 porcelain material with the optimum cement for assembly and fittings.

Metallic hardware connections can easily be designed using high-grade material for fittings according to customer specifications.

PPC INSULATORS

Railway Insulators
Introduction

Mechanical Design

In-service stresses for catenary insulators are mainly due to tension or bending loads (e.g., tension and vibration in wires, feeder, wind pressure, ice, short circuit loads). Few applications induce compression strength (depending on catenary mounting arrangement) or torsion strength when using as rotating air disconnects.

Designing for H.S.T. (High Speed Train) needs to take into account high security for railway lines. **PPC** experience in this field (more than 25 years), has led us to use special high-grade material for the porcelain body with an appropriate shed design.

PPC Insulators manufacturing plants mainly use C130 body for this range of insulators (catenary or post insulators) because of its high-grade high-quality properties. This allows a smaller core diameter, smaller sized fittings and makes insulators lighter.

Material data according to IEC 60672

Indicative mean values on test samples

Material	Flexural Strength Unglazed	Flexural Strength Glazed	Modulus of Elasticity	Linear thermal Expansion Coefficient*	Specific Weight
	Mpa psi	Mpa psi	x 10 ^{3} Mpa psi	x 10 $^{-6}$ K $^{-1}$	
C120 body	100 14500	140 20300	70 10150	4.5 to 5.5	2.4
C130 body	165-180 23925-26100	190-200 27550-29000	100 14500	4 to 6	2.7

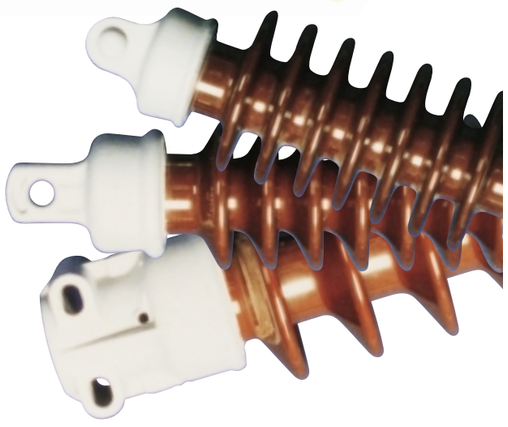
* Temperature range from 20°C to 300°C

Fittings

Material for Fittings is usually malleable cast or ductile iron. Protection against corrosion is made by **hot dip galvanizing according to IEC 60383-60168.** For galvanization, we recommend **a minimum nominal thickness of ≥ 85µm (or 3.3 mil).**

PPC Insulators can design and provide High Grade aluminium for fittings as an alternative for our customers. Standard sizes for fittings for busbars or air disconnect switches are used.

We can design fittings for Catenary Insulators of any kind according to the standard live parts connection for clamping based on customer usage.



Mechanical Data for Fittings

Standard indicative values on test samples

Material	Tensile Strength	Modulus of Elasticity	Linear Thermal Expansion Coefficient	Specific Weight
	Mpa psi	x 10 ^{3} Mpa psi	x 10 $^{-6}$ K $^{-1}$ psi	
Malleable cast iron	350 50750	230 33350	11	7.35
Ductile cast iron	400 58000	250 36250	11	7.2
Aluminium alloy casting Al-Si-Mg	250-290 36250-42050	210 30450	21	2.7

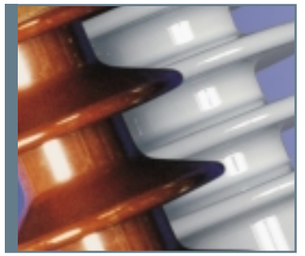
Railway Insulators
Design

Railway Insulators Design

Glazing

Brown Glaze

is according to RAL 8017 & RAL 8016



Grey Glaze

is according to RAL 7038 or ANSI Z55.1. (MUNSELL 5BG7.0/0.4) Grey glazed insulators provide an enhanced visual aesthetic advantage and compliment the tone of the metallic poles. These neutral colors blend well with most environments in which it is situated.

Semi-conductive glaze (SCG) can be provided for special polluted environments.
We also have developed state-of-the-art shed design to optimize performance.

Electrical Performance

Creepage distance calculations and performance have been improved through our relationships with our customers the world over.

Mechanical performance, too, has been enhanced through the rigors of speeding along at more than 300 km/hour (~ 190 mph.), requiring excellent knowledge concerning the electrical behavior of railway insulators and their mounting arrangment on-site.

Pollution performance is one of the most important points to consider when designing a railway insulator. Furthermore, we must take into account the kind of pollution and its severity according with pollution class levels from IEC 60815.

For each application, PPC Insulators offers the best choice for the design by using "K-Value" method and for the quality surface (e.g. SCG).

Railway Insulators
Design

Level	Pollution	Specific Creepage Distance	
1	Light	16 mm/kV	0.630 inch/kV

› Areas without industry and with low housing density equipped with heating plants.

› Areas with low density of industry or houses but subjected to frequent winds and/or rainfall.

› Agricultural areas.

› Mountainous areas.

Level	Pollution	Specific Creepage Distance	
2	Medium	20 mm/kV	0.787 inch/kV

› Industrial areas not producing particulate polluting smoke and/or with average housing density equipped with heating plants.

› Areas with high density of houses and/or industry but subjected to frequent winds and/or rainfall.

› Areas exposed to wind from the sea but not too close to the coast (at least several kilometers distant).

Level	Pollution	Specific Creepage Distance	
3	Heavy	25 mm/kV	0.984 inch/kV

› Areas with high density of industries and suburbs of large cities with high density of heating plants producing pollution.

› Areas close to the sea in any case exposed to relatively strong winds from the sea.

Level	Pollution	Specific Creepage Distance	
4	Very Heavy	31 mm/kV	1.220 inch/kV

› Areas generally of moderate extent, subjected to conductive dusts and to industrial smoke producing particularly thick conductive deposits.

› Areas generally of moderate extent, very close to the coast and exposed to sea-spray or to very strong and polluting winds from the sea.

› Desert areas, characterized by no rain for long periods, expsed to strong winds carrying sand and salt, and subjected to regular condensation.

Pollution Levels

Guidance on design and selection of creepage distance with respect to environmental conditions can be found in IEC recommendation 60815. Basic levels of pollution are qualitatively defined with examples of typical environment situations. Corresponding minimum nominal creepage distance is given in mm/kV.

K-value Design

Increased Pollution Performance Equalized Field Distribution

K-value design is a method to improve traditional creepage distance.

In its full extent, K-value design is a method to reduce
› **weight** › **volume and** › **space**
while improving properties in service by increasing pollution performance and equalizing electrical field.

International standard IEC 60507 defines form factor as:

$$F = \int dl / p(l)$$

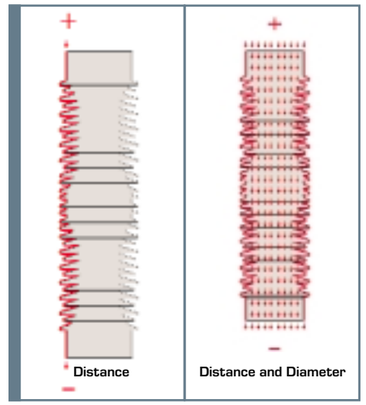
l is the creepage distance
p(l) is the circumference of the insulator as a function of l.

Form factor used as a design method is referred to as K-value and can be used for different improvements.

Creepage distance considers a leakage current as traveling along the exterior contour of the insulator, identifying only the linear distance.

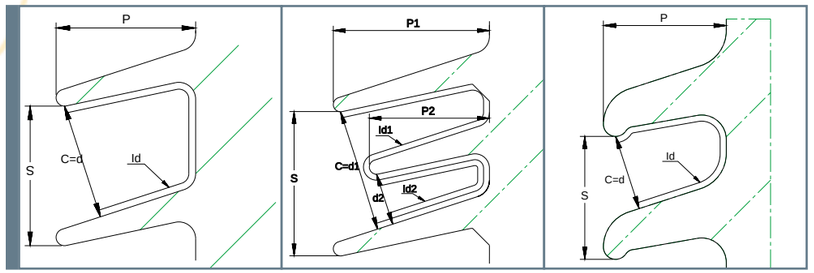
K-value considers a leakage current as traveling along the insulator over its surface. K-value identifies an insulator's total shape, i.e., geometric (ohmic) resistance against leakage currents. It is necessary to calculate the shape of the surface of the insulator for reaching optimum pollution performance.

Traditional calculation of creepage distance is still used, but to achieve best performance in relation to material and space used, K-value design is essential.



PPC Insulators offer complete computer design of K-value, integrated with traditional requirements.

Shed design

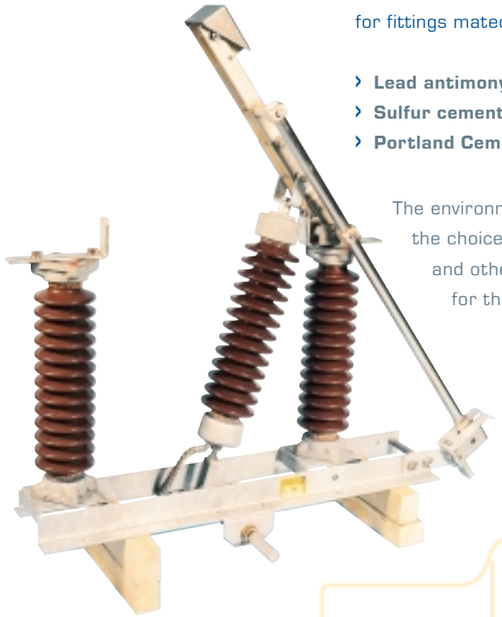


Plain Shed — **Alternating** Shed — **Standard** Shed

We recommend the plain or alternating sheds for general uses because of their best self-cleaning properties. According to our research, choosing an appropriate shape for sheds is also important for the optimum behavior against impact .

Railway Insulators
Product Features

Assembling



PPC Insulators uses three kinds of assemblies
for fittings mated to the porcelain:

- **Lead antimony alloy** from -50°C to 150°C
- **Sulfur cement** from -50°C to 80°C
- **Portland Cement base** from -30°C to 105°C

The environmental conditions and the use of insulators dictates the choice of assembly. Temperature, specific mechanical strength, and other parameters must be considered to make the right choice for the best performance of the insulators.

Hardware (when applicable)

PPC Insulators can deliver metallic hardware after agreement with the railway utility.

Tolerances

General tolerances	**± (0.04 d + 1.5) mm**	when d< 300
	± (0.025 d + 6) mm	when d> 300

Specific tolerances (When applicable)

Angular deviation of fixing holes	According to IEC 60273
Parallelism of end faces	According to IEC 60273
Eccentricity	According to IEC 60273
Axial, Radial, Angular displacements	According to IEC 60383

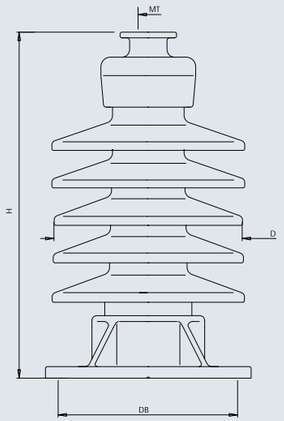
Railway Insulators

Pantograph Post

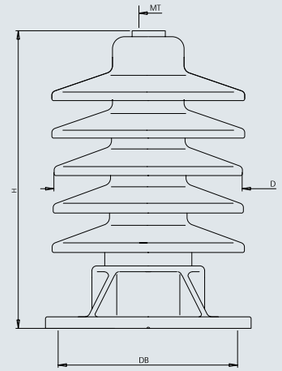
for trains and locomotives

PPC Insulators can provide a large range of insulators according to each use for locomotive and rail line builders.

Our design department can assist with custom solutions, e.g., posts with special end fixing, bushings fixed on the roof of the train.



Type A



Type B

Typical System voltage	25 kV A.C.	
Type	A	B
PPC Catalog N°	114713	115821
Glaze Color	**Brown**	**Brown**
Main dimensions (mm)		
Height "H"	360	300
Shed Diameter "D"	205	220
Bottom Fixing "DB"	4 Ø16/184	4 Ø16/184
Top Fixing "MT" (*)	M18 x20	M18 x25
Leakage distance	720	720
Mechanical Values		
Tensile (kN)	45	30
Cantilever (kN)	18	10
Electrical Values (kV)		
Wet Power Frequency -1min.	70	70
Lightning impulse (+) & (-)	170	170
Approximative Weight (Kg)		
	15	12

(*) "M" when metric threaded hole

Railway Insulators

Overhead Line Catenary

Top Guy & Bracket Insulators/Feeder Insulators

25 kV A.C. Overhead Line Catenary Insulators

Typical System voltage	25 kV A.C.							
Type	A	A	A*	B	B	B*	C	D*
PPC Catalog N°	113601	113602	114666	113603	113604	114665	113088	115666
Glaze Color	**Brown**	**Brown**	**Sky blue**	**Brown**	**Brown**	**Sky blue**	**Brown**	**Sky blue**
Main dimensions (mm)								
Height "H"	500	625	625	490	615	615	500	560
Shed Diameter "D"	188	198	198	188	198	198	125	160
Tube Diameter "D Tube"	49	49	49	28	28	28	N/A	N/A
Bottom Fixing "DB"	18	18	18	N/A	N/A	N/A	20.5	N 16
Top Fixing "DT"	N/A	N/A	N/A	18	18	18	20.5	20
Bottom Thickness "EB"	16	16	16	N/A	N/A	N/A	19	N/A
Top Thickness "ET"	N/A	N/A	N/A	16	16	16	19	N/A
Leakage distance	800	1200	1200	800	1200	1200	530	1200
Mechanical Values								
Tensile (kN)	80	80	80	50	50	50	130	30
Cantilever (kNm)	2.45	2.45	2.45	1	1	N/A	4	N/A
Electrical Values (kV)								
Wet Power Frequency -1min.	70	95	95	70	95	95	80	95
Lightning impulse (+) & (-)	170	250	250	170	250	250	170	250
Approximative Weight (Kg)								
	15	18	20	14	17	19	13	14

* Insulators used for High Speed Trains

15 kV A.C., 1.5 - 3.3 kV D.C. Overhead Line Catenary Insulators

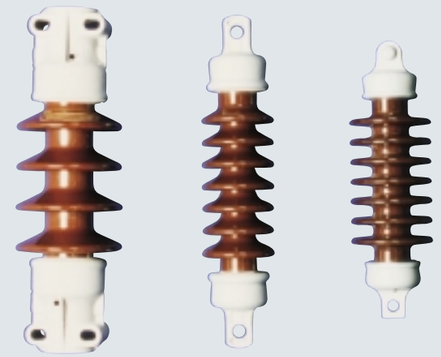
Typical System voltage	15 kV A.C.						3.3 kV D.C.		1.5 kV D.C.	
Type	A**	B**special	C**	C**	A***	C***	A	B	C	C
PPC Catalog N°	4Ebs 13 02 21	4 Ebs 13 02 22	Ebs 4 13 02 11	Ebs 213 01 03	ED 6519	ED 6513	115493	115492	116038	116040
Glaze Color	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**
Main dimensions (mm)										
Height "H"	550	570	485	440	632	505	380	363	400	455
Shed Diameter "D"	175	184	162	180	140	120	158	158	125	150
Tube Diameter "D Tube"	42/55/ 60/70	42/55/ 60/70	N/A	N/A	49	N/A	57	38	N/A	N/A
Bottom Fixing "DB"	21	N/A	21	21	N/A	N 16	18	N/A	24	26
Top Fixing "DT"	N/A	N/A	21	21	N/A	N 17	N/A	18	24	26
Bottom Thickness "EB"	19	N/A	19	19	N/A	N/A	16	N/A	18	18
Top Thickness "ET"	N/A	N/A	19	19	N/A	N/A	N/A	16	18	18
Leakage distance	760	760	760	565	690	690	360	360	250	250
Mechanical Values										
Tensile (kN)	120	120	100	100	72	70	64	64	75	150
Cantilever (kNm)	2.6	3.5	N/A	N/A	N/A	N/A	1.7	1.7	N/A	N/A
Electrical Values (kV)										
Wet Power Frequency -1min.	65	65	65	75	100	100	38	38	28	28
Lightning impulse (+) & (-)	195	190	145	200	220	220	95	95	60	60
Approximative Weight (Kg)										
	15	16	14	11	12	8	10	10	9	16

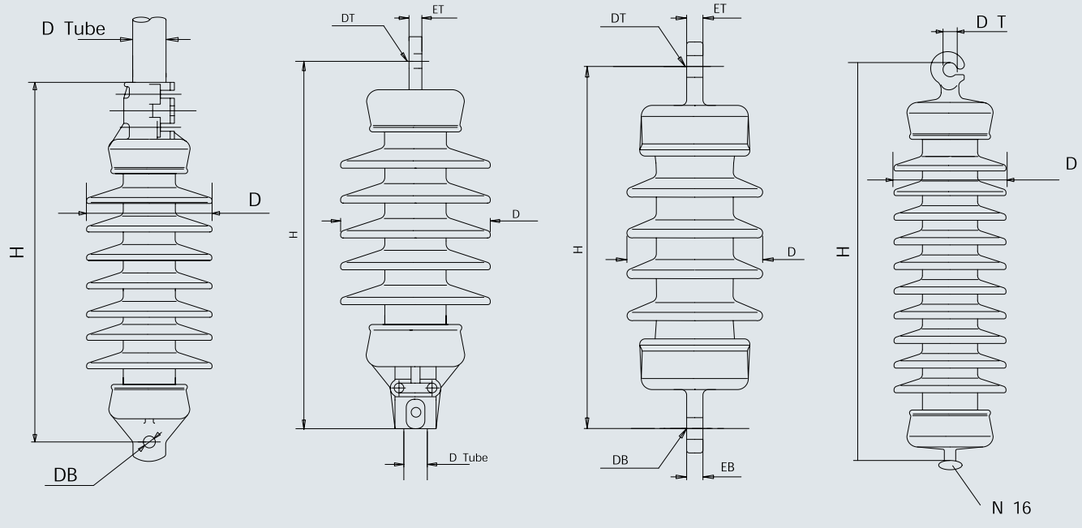
B** special End fixing of insulators are tube on both sides. ** Insulators used for German Railways *** Insulators used for Austrian & Swiss Railways

The single-piece core design for 3 kV DC or 25 kV AC with special design provides maximum protection after flashovers and against mechanical impact.

PPC Insulators designed for working in the horizontal position or angle mounted on a crossarm provides maximum safety for the electrical line connection with the train.

We supply the entire range of insulators for each voltage level:
1.5 – 3 kV DC
15 – 25 kV AC





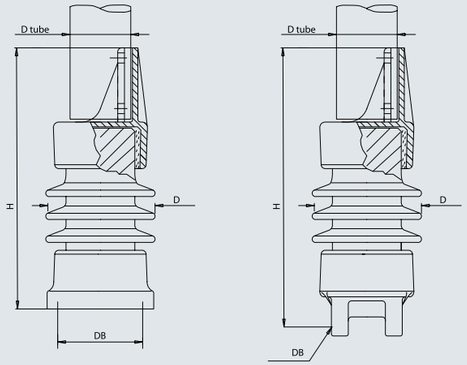
Type A **Type B** **Type C** **Type D**

Railway Insulators

Post Catenary

In some applications (e.g., tunnels, bridge crossings),
PPC Insulators can design insulators with reduced dimensions.

Rigid Post or Post-with-Anchoring-Hole types
are available for situations of reduced clearance.



Type A

Type B

Typical System voltage	15 kV A.C.			1.5 kV D.C.	
Type	A	B	B	B	A
PPC Catalog N°	377 00 07	ED 6507	ED 6518	116039	116041
Glaze Color	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**
Main dimensions (mm)					
Height "H"	598	574	574	406	388
Shed Diameter "D"	185	140	140	162	162
Tube Diameter "D Tube"	70	43	49	89	89
Bottom Fixing "DB"	4 Ø18/140 *	Ø19-L103(^)	Ø19-L103(^)	Ø22-L120(^)	4 M 16/127
Leakage distance	700	690	690	250	250
Mechanical Values					
Tensile (kN)	N/A	72	72	12.5	12.5
Cantilever (kNm)	2.5	N/A	N/A	10	10
Electrical Values (kV)					
Wet Power Frequency -1min.	70	100	100	28	28
Lightning impulse (+) & (-)	170	220	220	60	60
Approximative Weight (Kg)					
	27	12	12	17	17

* Pitch square 140x140mm (^) For Anchor hole,dimension of the pin is given "M" when metric threaded hole

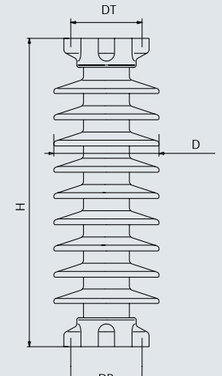
Railway Insulators

Posts and Rods

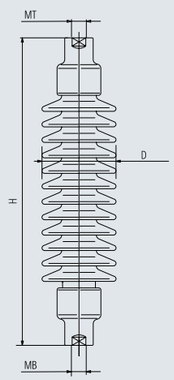
for Air Disconnect Switches

Transmitting power to the railway line requires
busbars and air disconnect switches.
Typical post and rod insulators are used
for insulating live components.

Considering each on-site installation, our
PPC Insulators are available to work upright,
underhung or even in the horizontal position.



Type A



Type B

Choosing the best design for several possibilities
of site use provides flexibility for our customers to
consider the optimum arrangement for each mounting.

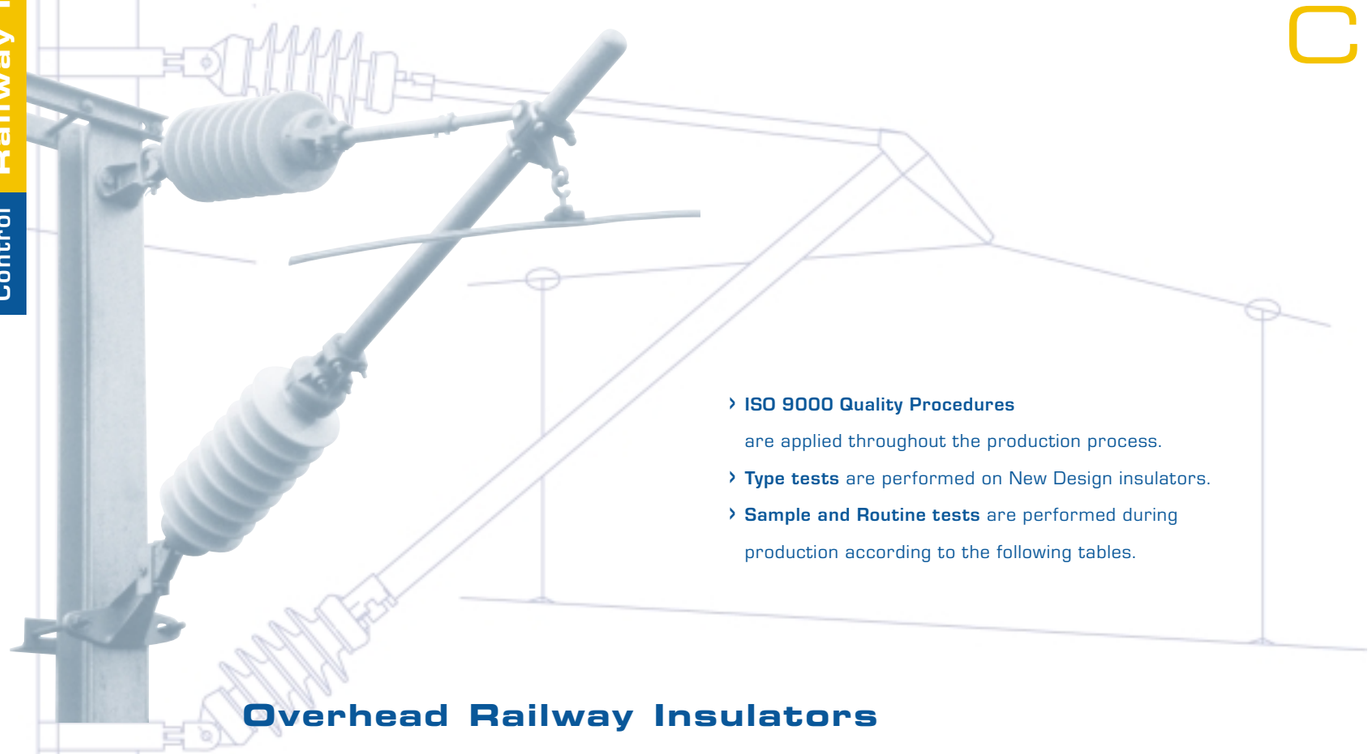
For instance, fast trains crossing under bridges
require posts hanging the feeder cable as stable
as possible to prevent power disruption.

Posts & Rods Insulators used for Air Disconnect Switch and as post for feeder wire

Typical System voltage	25 kV A.C.			3.3 kV D.C.		1.5 kV D.C.
Type	A	A	B	A	A	A
PPC Catalog N°	114012	114013	115662	113608	113607	116042
Glaze Color	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**	**Brown**
Main dimensions(mm)						
Height "H"	420	560	885	245	343	295
Shed Diameter "D"	195	200	120	155	155	162
Bottom Fixing "DB"	4 M16/127	4 M16/127	N/A	2 Ø15/130	4 Ø12/50 *	4 M16/127
Top Fixing "DT")	4 M16/127	4 M16/127	N/A	2 Ø15/130	4 Ø12/50 *	4 M16/127
Leakage distance	840	1200	1200	360	360	250
Mechanical Values						
Tensile (kN)	60	60	27	50	50	4
Cantilever (kNm)	5	5	N/A	2.7	1	4
Torsion (kNm)	5.5	5.5	N/A	0.7	0.7	N/A
Electrical Values (kV)						
Wet Power Frequency -1min.	70	95	95	38	38	28
Lightning impulse (+) & (-)	170	250	250	95	95	60
Approximative Weight (Kg)						
	19	26	12	7	8	15

(*) "M" when metric threaded hole * Pitch square 50x50mm

Railway Insulators Control



- **ISO 9000 Quality Procedures** are applied throughout the production process.
- **Type tests** are performed on New Design insulators.
- **Sample and Routine tests** are performed during production according to the following tables.

Conversion table

1 inch	25.4	mm
1 pound	4.448	N
1 inch-pound	0.113	Nm
1 mm	39.374	mils

Overhead Railway Insulators

IEC 60383-1/2	Design Test	Sample Test	Routine Test
	§ 6.1	§ 6.2	§ 6.3
Dry lightning impulse withstand voltage test § 13	✓		
Wet power-frequency withstand voltage test § 14	✓		
Puncture withstand test (only on insulators class B) § 15		✓	
Routine electrical test (only on insulators class B) § 16			✓
Mechanical failing load:			
Tensile strength § 19.2 - 19.4 - 33	✓	✓	
Bending strength (where applicable) § 19.1	✓	✓	
Thermal-mechanical performance test § 20 -33	✓		
Verification of dimensions § 17-21		✓	
Temperature cycle test § 23.1		✓	
Verification of locking system (where applicable) § 22		✓	
Visual inspection § 27			✓
Porosity test § 25		✓	
Galvanizing Test (where applicable) § 26		✓	
Routine mechanical test § 28			✓

Posts and Rods

IEC 60168	Design Test	Sample Test	Routine Test
	§ 6.1	§ 6.2	§ 6.3
Dry lightning impulse withstand voltage test § 13	✓		
Wet power-frequency withstand voltage test § 14	✓		
Puncture test (only on insulators class B) § 4.9		✓	
Routine electrical test (only on insulators class B) § 4.10			✓
Mechanical failing load:			
Bending strength § 5.2.4	✓	✓	
Torsion test (when applicable) § 5.2.5	✓	✓	
Tensile test (when applicable)	✓		
Verification of dimensions § 5.1		✓	
Temperature cycle test § 5.4		✓	
Visual inspection § 5.8			✓
Porosity test § 5.6		✓	
Galvanizing Test § 5.7		✓	
Routine mechanical test § 5.9			✓

SEVES

The very Best.

RTV Silicone Coating

PPC INSULATORS

RTV Silicone Coating.
High Voltage

Contamination leads to flashovers

Extreme environmental conditions and high pollution areas such as industrial, desert and coastal regions cause excessive leakage currents. The surface condition of an insulator in such areas will subsequently lead to a pollution flashover and power system outages. To avoid the electrically conductive layer, resulting from an accumulation of pollutants in combination with moisture, frequent washing or greasing of the insulators is necessary to ensure safe operation. The consequences are high maintenance cost and profit losses because of regular station shut downs and interruptions in electricity supply.

The need for reliable power networks, the avoidance of blackouts, and substation shutdowns due to frequent maintenance procedures led the insulation industry to react. Starting in the early 90's, **PPC**'s research on room temperature vulcanized silicone rubber coatings, RTV, was initiated by the group's production facility in Sonneberg, Germany. POWERSIL® rubber emerged as the perfect material for use with **PPC** porcelain insulators due to its long-lasting hydrophobic property. A special spray coating technique was developed to evenly apply the POWERSIL® material on the porcelain in a layer thickness of 0.5 mm (19 mils).

Insulator Coating.

PPC high voltage insulator coatings work on the principle of providing a hydrophobic surface limiting the leakage current to harmless levels in the presence of moisture and contamination.

Benefits of RTV-Coating

› Excellent self cleaning characteristics and long-term resistance to weathering and difficult environments

› Long-term hydrophobicity due to the migration of low molecular weight (LMW) siloxanes into the pollution layer

› Suppression of leakage current, discharges and pollution flashover

› Reduced maintenance expenditures, as in washing, compared to conventional insulator surfaces

› Facilitated cleaning in case of extreme pollution deposition (e.g. cement); even most difficult pollutants can be wiped off by cloth

› RTV coated surfaces withstand high pressure jet washing up to 90 bar (normal application, 25cm distance)

› The best of both worlds, mechanical strength of porcelain and pollution performance of silicone rubber

› Long-term RTV stability makes repeated application of grease unnecessary

› Minimum 15 years as experienced and reported by STRI

› Non toxic and environmental friendly material

› Transmission reliability as well as environmental and resource conservation by efficiently utilizing generated power

RTV silicone coating can also be applied in normal contaminated areas, thus reducing maintenance expenditures and revenue losses because of required station shut downs for insulator washing.

PPC Solutions.
Porcelain strength

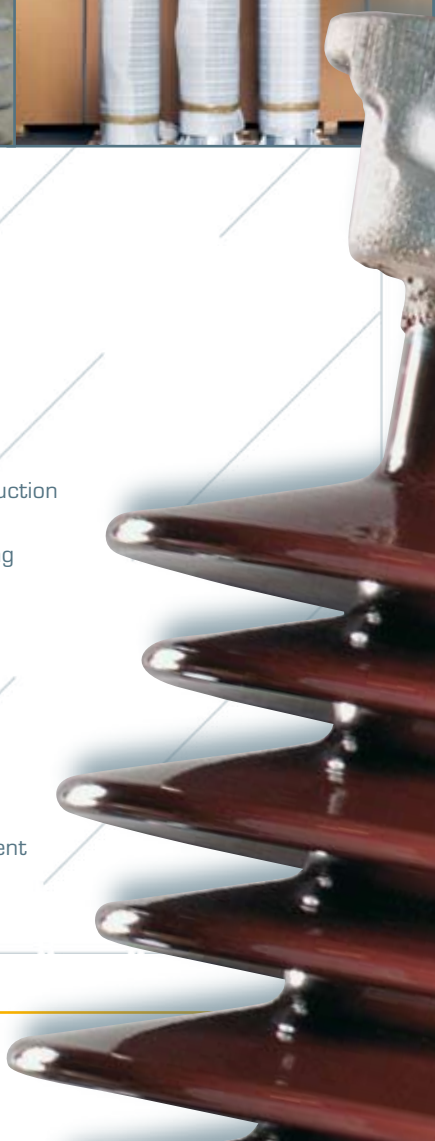
RTV covering **PPC** manufactured insulators with a silicone layer will combine the porcelains undisputed superiority of high mechanical strength as well as its longevity due to inorganic material with the composites excellent behavior in areas with excessive pollution. The insulators hydrophobic surface is combating negative effects of contamination and is enhancing the electrical insulation characteristics and low leakage currents in highly polluted areas.

Solution 1: In-House Coating

In-house coating is especially advantageous for projects using new insulators. No preparation for coating is needed and new, clean insulators are coated within the controlled environment of **PPC** production facilities – where as outside weather conditions or the surface conditions of the insulator need to be addressed when coating insulators „On-Site". A product ready to be installed is delivered.

PROCESS

- Porcelain insulator production
- Insulator surface cleaning and masking
- Surface RTV coating
- Coating Inspection
- Hydrophobicity check
- Suitable packing to prevent handling damage



meets hydrophobicity.

Solution 2: On-Site Coating

Upgrading existing substation equipment is possible by on-site coating.
A trained and experienced coating team is sent to the de-energized substation.
Before applying the silicone layer, preparation and cleaning of the insulator needs to be done. **PPC** On-site coating is environmentally friendly – no dangerous or hazardous materials are used.

PROCESS

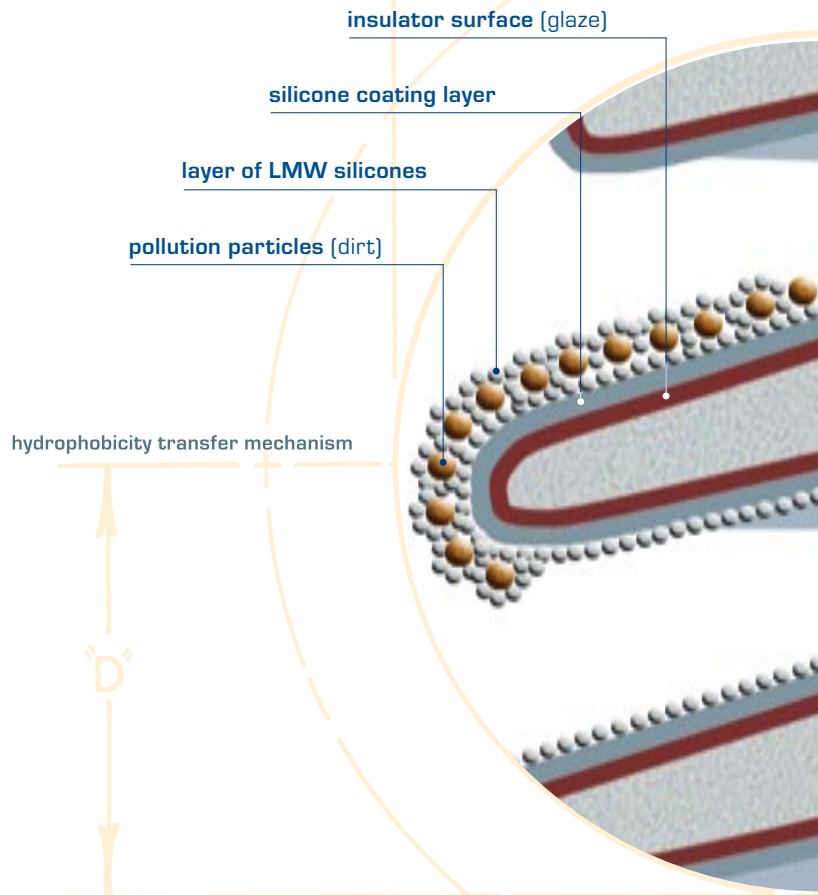
- Substation de-energizing
- Wind/dust protection platform
- Insulator surface cleaning and masking
- Surface coating
- Coating Inspection
- Hydrophobicity check
- Substation re-energizing

PPC is one of the very few insulator manufacturers able to offer both solutions of RTV coating directly to our customers without involving an external company for this service.

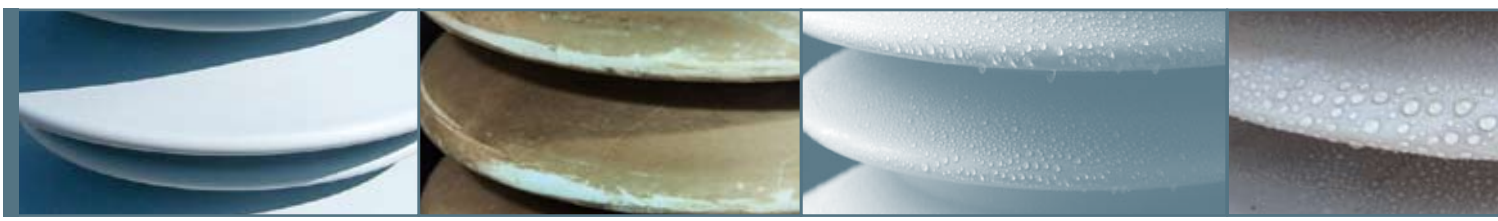
Hydrophobicity.
Reducing Leakage

Porcelain insulators show high surface energy with polar molecule groups that are highly wettable. When contaminated and wetted, leakage current develops on the porcelain insulator which may lead to flashover and consequently, power system outages may occur.

The substitution of polar molecule groups by non-polar molecule groups ensures that hydrophilic surfaces become hydrophobic. This is the result when coating the porcelain insulator with a layer of room temperature vulcanizing (RTV) silicone rubber. Low molecular weight (LMW) components are responsible for the hydrophobic surface of the coating. Water repellency and a low surface energy will be obtained on hydrophobic surfaces.



Long lasting hydrophobicity – even on contaminated surfaces



Permanent hydrophobicity is possible due to the hydrophobicity transfer to the pollution layer. In the case of pollution particle deposition on the coating layer, the LMW will spread from the silicone bulk material to the pollution layer and encapsulates these particles within a short time period. Now the surface of the insulator is hydrophobic once again.

Current.

Substation 110kV
Germany

Flashover problems caused by salt fog contamination of the nearby highway during wet seasons on post insulator, bushings, surge arresters, current transformers and hollow insulators.

PPC experience.

In-House & On-Site

With almost two decades of experience and customers satisfaction, it is evidence of the premium quality and long lasting hydrophobic properties of the material used and the excellent coating technique developed within PPC. Even in heavy polluted areas, two decades after the first coating, no re-coating is needed. The very Best. That's what we deliver.

Substation 380kV
Spain

Coating of post insulators for disconnectors because of corona discharges on insulators close to Mediterranean Sea
Severe contaminated layer on the surface of insulators caused by salt fog and industrial pollution.

Substation 380kV
Netherlands

Corona discharges on circuit breakers were observed on the insulators surfaces during operation because of industrial pollution (sea port area) and salt fog pollution (close to North Sea).

www.ppcinsulators.com

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Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support. **PPC** Insulators quality products and service provide time-tested value to fulfill your needs!

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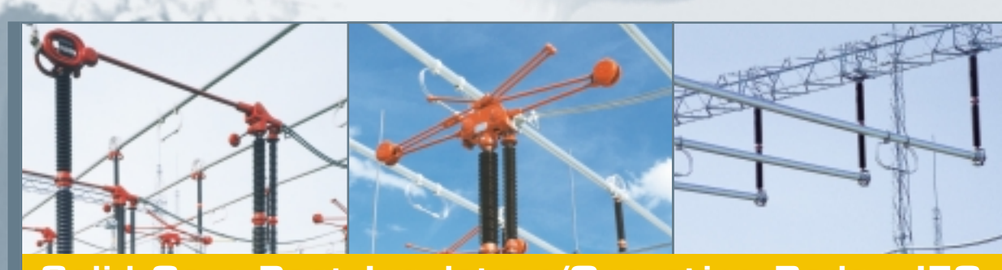


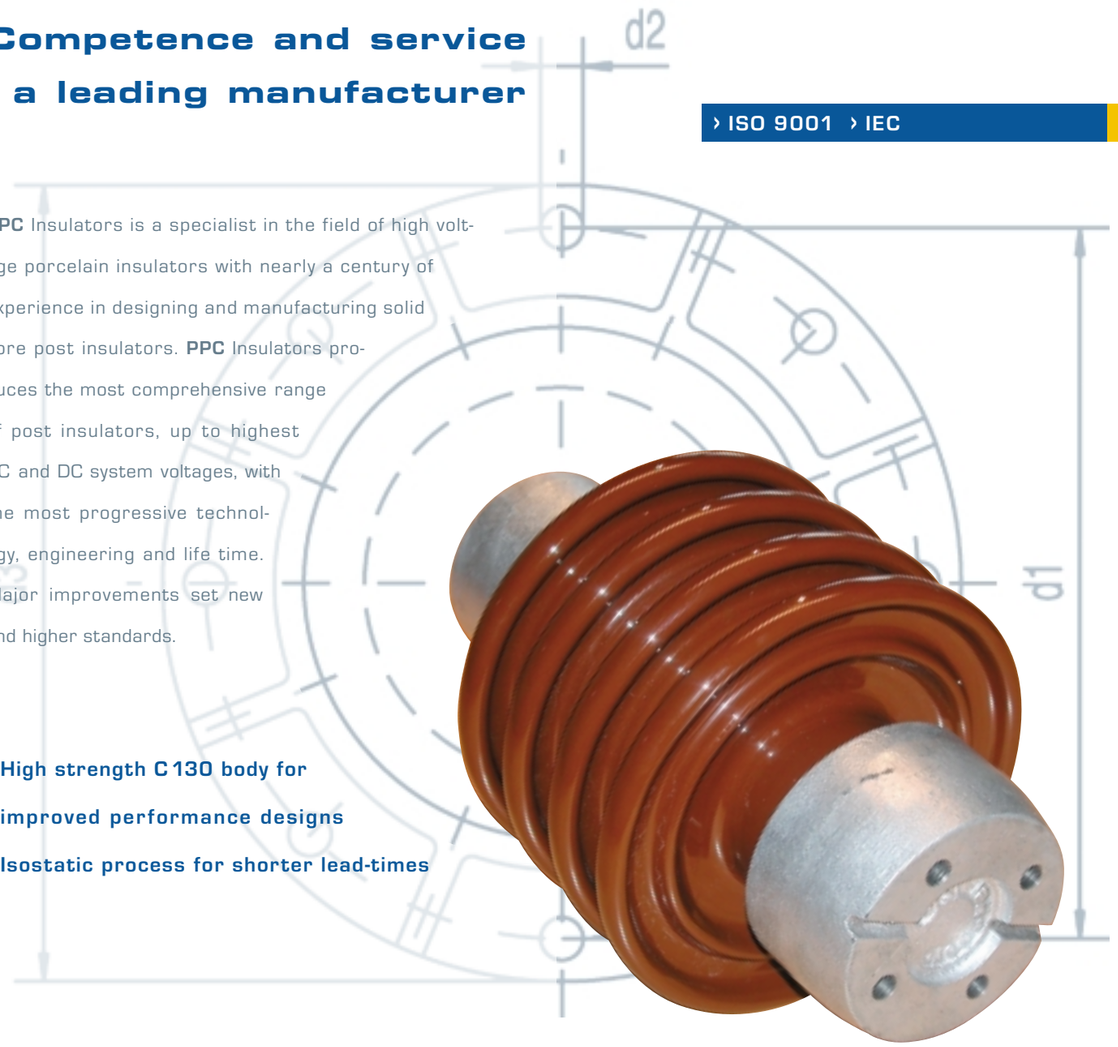
Solid Core Post Insulators/Operating Rods - IEC

PPC INSULATORS

Superior Reliability.
A Century of Experience

Competence and service by a leading manufacturer

PPC Insulators is a specialist in the field of high voltage porcelain insulators with nearly a century of experience in designing and manufacturing solid core post insulators. **PPC** Insulators produces the most comprehensive range of post insulators, up to highest AC and DC system voltages, with the most progressive technology, engineering and life time. Major improvements set new and higher standards.



- **High strength C 130 body for improved performance designs**
- **Isostatic process for shorter lead-times**

› ISO 9001 › IEC

Index

PPC INSULATORS

Solid Core Post Insulators
Introduction

Solid Core Post Insulators
Design

Introduction

Post insulators are designed to comply with the demands of the level of electrical insulation and mechanical strength, while also taking into account the environmental situation where the insulators are intended for service. To specify the correct standard outdoor porcelain solid core post insulator, the following characteristics have to be defined:

- Lightning impulse withstand voltage, dry
- Switching impulse withstand voltage, wet (when a switching impulse level is required)
- Power frequency withstand voltage, wet
- Mechanical failing load
- Minimum nominal creepage distance
- Fixing arrangement of top and bottom metal fitting
- Color of glaze

Standards

PPC Insulators manufactures outdoor porcelain solid core post insulators with external metal fittings and outdoor operating rods with external metal fittings (for High Voltage Switchgears) according to standard IEC60273. Components according to other standards or special customer requirements can be supplied upon request.

According to IEC60273, an IEC post insulator is defined by the following designation:

IEC post insulator Type C10-1050-II

- **C** means outdoor post insulator with external metal fittings
- **10** means a minimum bending failing load of 10 kN
- **1050** means a lightning impulse withstand voltage, dry of 1050 kV
- **II** means creepage distance class II (in reference to IEC60273)

According to IEC60273, an IEC operating rod can be defined by the following designation:

IEC operating rod Type T3-1050-II

- **T** means outdoor operating rod with external metal fittings
- **3** means a minimum failing load torsion 3 kNm
- **1050** means a lightning impulse withstand voltage, dry of 1050 kV
- **II** means creepage distance class II (in reference to IEC60273)

These designations do not always fully specify the insulator type; sometimes there are alternative constructions regarding the fixing arrangement and creepage distance included in the standards.

Solid Core Post Insulators
Design

Electrical Design

The insulation performance of a post insulator column is a function of the height, creepage distance, arcing distance of the insulating part(s) as well as the number of insulator units for a defined height and follows the standards IEC60071 and IEC60273.

Nominal system voltage Un	Highest system voltage Um	One minute withstand voltage wet 50 cs	Lightning impulse withstand voltage 1,2/50 μs
kV (r.m.s.)	kV (r.m.s.)	kV (r.m.s.)	kV (peak value)
3	3,6	10	20 40
6	7,2	20	40 60
10	12	28	60 75 95
15	17,5	38	75 95
20	24	50	95 125 145
30	36	70	145 170
45	52	95	250
66	72,5	140	325
110	123	185 230	450 550
132	145	185 230 325	450 550 650
150	170	230 275 325	550 650 750
220	245	275 325 360 395 460	650 750 850 950 1050

Nominal system voltage Un	Highest system voltage Um	Switching impulse withstand voltage 250/2500 μs	Lightning impulse withstand voltage 1,2/50 μs
kV (r.m.s.)	kV (r.m.s.)	kV (peak value)	kV (peak value)
275	300	750 850	850 950 1050
330	362	850 950	950 1050 1175
380	420	850 950 1050	1050 1175 1300 1425
480	525 (550)	850 950 1050	1175 1300 1425 1550
700	765 (800)	1300 1425 1550	1675 1800 1950 2100

Solid Core Post Insulators
Design

RIV

The **RIV performance** of single post insulator styles will be tested in accordance with the **standard IEC60437** upon request. If corona rings are necessary to reach a certain RIV level for a single insulator column, the appropriate ones will be offered with the insulator column.

Mechanical Design

In-service stresses on post insulators are mainly due to bending loads (e.g., weight, wind force, seismic conditions, short circuit loads). A few applications require compression strength (e.g., capacitors banks) or torsion strength (e.g., rotating disconnectors) or tensile strength (e.g., underhung post insulator).

The high strength C 130 porcelain body allows for a reduction in the number of components on insulators comprised of multiple units. The advantages provided by the reduction of additional fittings include increased arcing distance/creep and less assembly time. All insulators up to and including the C 20-1050 are available in a one-unit design.

Pollution Levels and Creepage Distances

Level	Pollution	Specific Creepage Distance	
1	Light	16 mm/kV	0.630 inch/kV

› Areas without industry and with low housing density equipped with heating plants.

› Areas with low density of industry or houses but subjected to frequent winds and/or rainfall.

› Agricultural areas.

› Mountainous areas.

Level	Pollution	Specific Creepage Distance	
2	Medium	20 mm/kV	0.787 inch/kV

› Industrial areas not producing particulate polluting smoke and/or with average housing density equipped with heating plants.

› Areas with high density of houses and/or industry but subjected to frequent winds and/or rainfall.

› Areas exposed to wind from the sea but not too close to the coast (at least several kilometers distant).

Level	Pollution	Specific Creepage Distance	
3	Heavy	25 mm/kV	0.984 inch/kV

› Areas with high density of industries and suburbs of large cities with high density of heating plants producing pollution.

› Areas close to the sea in any case exposed to relatively strong winds from the sea.

Level	Pollution	Specific Creepage Distance	
4	Very Heavy	31 mm/kV	1.220 inch/kV

› Areas generally of moderate extent, subjected to conductive dusts and to industrial smoke producing particularly thick conductive deposits.

› Areas generally of moderate extent, very close to the coast and exposed to sea-spray or to very strong and polluting winds from the sea.

› Desert areas, characterized by no rain for long periods, exposed to strong winds carrying sand and salt, and subjected to regular condensation.

The creepage distance should be increased in relation to the average diameter, D_m.

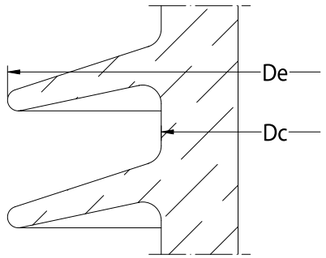
D_m <300 mm	k_d = 1.0
D_m 300-500 mm	k_d = 1.1
D_m >500 mm	k_d = 1.2

In standard IEC60273, creepage distances are standardized for post insulators in class I and II, which is not in accordance with the general recommendations of the guide IEC60815 "Guide for the selection of insulators in respect to environmental conditions".

In IEC60815 the basic pollution levels are defined qualitatively with examples of typical environmental situations. The corresponding minimum nominal creepage distance is given in mm/kV.

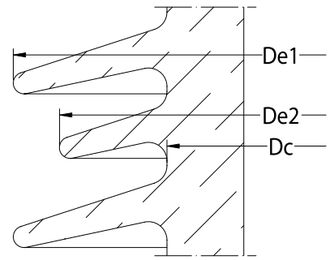
Regular sheds

$D_m = (De+Dc)/2$



Alternating sheds

$D_m = (De1+De2+(2*Dc))/4$

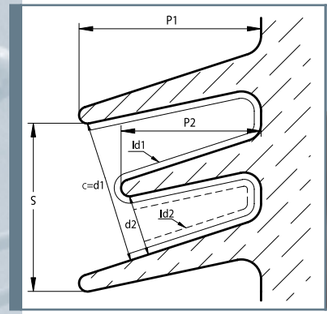


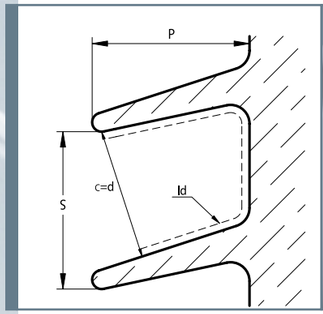
De Shed diameter
Dc Core diameter
De1 Greater shed diameter
De2 Smaller shed diameter

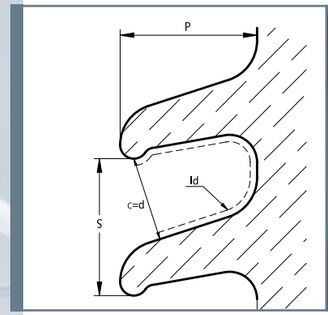
Solid Core Post Insulators
Design

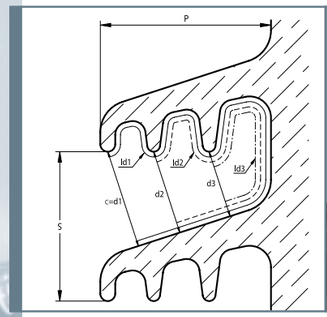
Shed Design

The plain alternative shed design offers high specific creepage distance together with good self-cleaning properties and usually provides best performance. Using flexible shed design can optimize most insulators.









Parameters Characterizing
Insulator Profile

1. Minimum distance, c, between sheds

- Generally c ≥ 30 mm.
- For small insulators (H < 550 mm) or overhang (p ≤ 40 mm), c can be ≥ 20 mm.

2. Ratio s/p between spacing and overhang

- Sheds without under ribs ≥ 0.65.
- Sheds with under ribs ≥ 0.8.

3. Ratio l_d/d between creepage distance and clearance

- This ratio must be calculated for the "worst case" on any section ($l_{d1}/d1$, l_{d2}/d_2).
- It must be < 5.

4. Alternating shed

- $p_1 - p_2 \geq 15$ mm

Parameters give basic rules to assist design. They relate to vertically installed insulators.

Parameters Characterizing
Entire Insulator

1. Creepage factor C.F.

$$C.F. = l_t / S_t$$

l_t total creepage distance of an insulator
S_t arcing distance

- C.F. ≤ 3.5 for pollution levels 1 and 2.
- C.F. ≤ 4 for pollution levels 3 and 4.

2. Profile factor P.F.

$$P.F. = \frac{2p_1 + 2p_2 + s}{l}$$ alternating sheds

$$P.F. = \frac{2p + s}{l}$$ all other sheds

l creepage distance of the insulated leakage path measured between the two points which define s.

- P.F. > 0.8 for pollution levels 1 and 2.
- C.F. > 0.7 for pollution levels 3 and 4.

Solid Core Post Insulators
Design

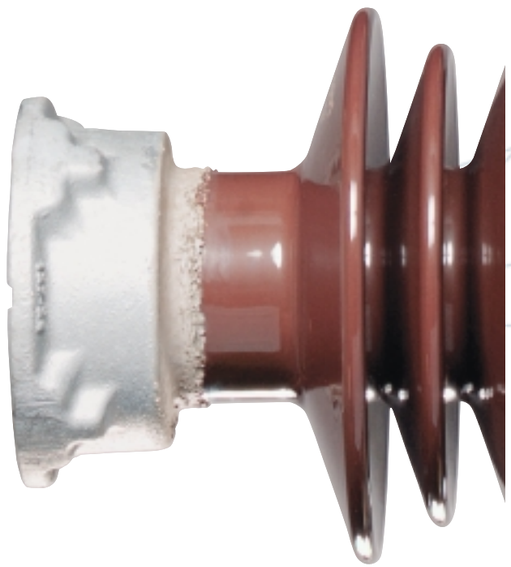
K-Value Increased Pollution Performance Equalized Field Distribution

K-value design is a method to improve traditional creepage distance. In its full extent, K-value design is a method to reduce weight, volume and space while improving properties in-service by increasing pollution performance and equalizing the electrical field.

K-value is the unit for insulator shape and IEC 60507 defines the formula as form factor:

$$F = \int dl / p(l)$$

l is the creepage distance
p(l) is the circumference of the insulator as a function of l.



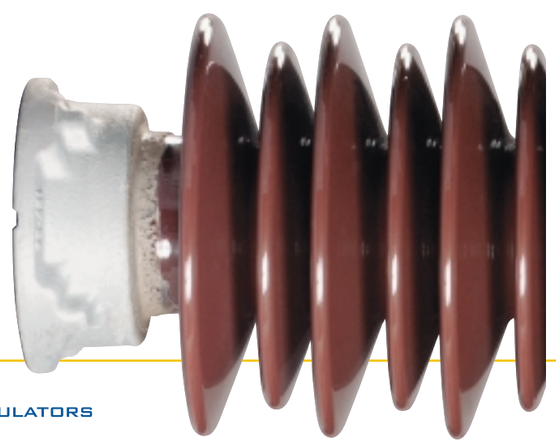
Form factor used as a design method is referred to as K-value and can be used for different types of improvements.

Creepage distance considers a leakage current as traveling along the insulator, in a strict line, identifying only distance.

K-value considers a leakage current as traveling along the insulator, over its complete surface. It calculates reduced diameter and/or increased creepage distance for higher resistance against the leakage currents. K-value identifies an insulator's total shape, i.e., geometric (ohmic) resistance against leakage currents.

The shape of the insulator must be calculated for optimum design of pollution performance. The traditional calculation of creepage distance is sometimes sufficient, but to achieve best performance in relation to material and space used, K-value design is necessary.

PPC Insulators offers complete computer design of K-value, integrated with electrical, mechanical, dimension and material calculations.



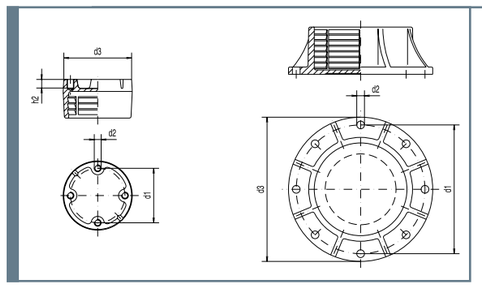
Insulating Material

The insulator body of the unit is made from high quality aluminium oxide porcelain, C 130 or C 120, which conforms to standard IEC60672. Glazing provides a dirt repellent surface. Glazing is normally brown in colour, though Munsell grey can also be provided upon request. Semi-conductive surface glazing can be provided for special polluted environments.

Fittings

Fittings are made in malleable cast iron according to standard EN1562 or spheroidal graphite cast iron according to standard EN1563.
All fittings are hot dip galvanized according to standard EN ISO 1461 with a zinc weight of min. 600 g/m² (min. 85 µm) as average value.
The following table shows the standard dimensions for fittings according to IEC60273.

Pitch circle diameter p.c.d. d_1	Depth of the tapped blind holes h_2	Number of holes n	Bolt holes tapped d_2	Bolt holes plain Ø d_2	Nominal maximum diameter of mounting face d_3
mm	mm	-	-	mm	mm
76	12	4	M12	-	115
127	18 (22)	4	M16	-	165
178		4	-	18	225
200		4	-	18	245
225		4	-	18	270
254		8	-	18	300
275		8	-	18	320
300		8	-	18	345
325		8	-	18	370
356		8	-	18	400
375		8	-	18	420



Fittings with other dimensions (e.g., for operation rod columns) can be supplied on request.

Threads are generally tapped after hot dip galvanizing; for shipment and storage, the threads will be protected by a protective layer and/or special plastic plugs.

NOTE: Multiple unit insulator columns will be delivered with hardware (bolts, nuts and spring washers) for the interconnection of the insulator units.

Solid Core Post Insulators
Production

Cementing

The fittings are assembled to the porcelain body with a Portland base mortar as standard. An alternative assembly with sulfur cement can be offered (for max. service temperature to 80°C). A bituminous coating is applied on the porcelain and the fittings to compensate for the difference in thermal expansion. This is especially important for extreme weather applications.

Marking

Each insulator carries the trademark of the **PPC** Insulators, the trademark of the manufacturing factory, type designation (reference number), date of manufacture and a serial number.

Inspection and Testing

Inspections and tests after firing are made according to standard IEC60168.

Tested Items	Type Test	Sample Test	Routine Test
Dry lightning impulse withstand voltage test	✓		
Wet switiching impulse withstand voltage test	✓[1]		
Wet power frequency withstand voltage test	✓		
Mechanical failing load test Bending strength	✓	✓	
Verification of dimensions		✓	
Temperature cycles test		✓	
Porosity test		✓	
Galvanising test		✓	
Visual inspection			✓
Mechanical test (Bending)			✓[2]

1 Applicable only to post insulators for use on systems with highest voltage for equipment above 245 kV
2 Insulators with height >770 mm

Solid Core Post Insulators
Production

Tolerances of Dimensions, Form and Position

The tolerances are in accordance with the standards IEC60168 and IEC60273.

› Dimensions for which no special tolerance is specified

± (0,04d + 1, 5) mm when d ≤ 300
± (0,025d + 6) mm when d > 300

d is the checked dimension in millimetres

› Creepage distance tolerance ± (0,04d + 1, 5) mm

d is the nominal creepage distance in millimetres

› Parallelism “p” of the endfaces

h ≤ 1m: p ≤ 0,5 mm
h > 1m: p ≤ 0,5*h mm

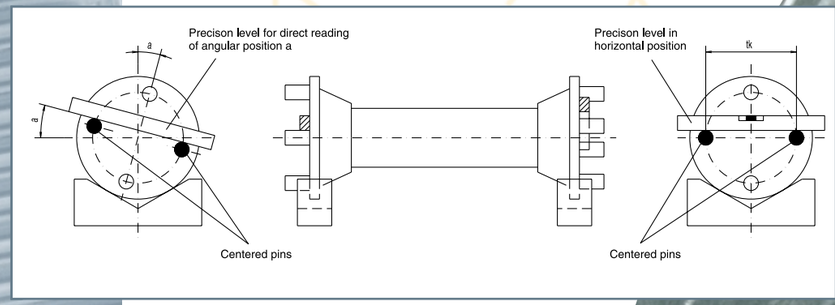
h is the height of the insulator unit in metres
p is related to a diameter of 250mm

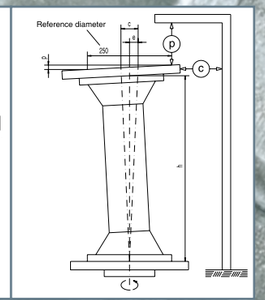
› Eccentricity “e” e = 2*(1+h)

h is the height of the insulator unit in metres

The centre line of the two fitting pitch circle diameters should fit into a cylinder with diameter c. c ≤ 2*e

› Angular deviation of fixing holes a a ≤ 1° standard





Advantages

of porcelain solid core post insulators with external fittings

- **puncture proof**
  The theoretical puncture path through the porcelain body is almost equal to the dry arcing distance.
  Since porcelain has several times the dielectric breakdown strength of air, flashover, if any, always occurs in the air outside the porcelain body.
- **insulator body made of aluminium oxide porcelain**
  - high mechanical strength
  - free of internal stresses
  - no measurable aging
  - resistant to salt pollution
  - high resistance to temperature variations
  - high resistance to vandalism
- **electrically and mechanically stressed zones are separated**
- **low surface leakage current resulting in reduced transmission losses**
- **the creepage distance is made from sheds and core parts which have**
  - good self-cleaning properties with respect to the climatic conditions
  - better insulation performance under pollution conditions
- **routine test load = 70 % of the minimum failing load**
- **can be checked ultrasonically for mechanical soundness**
- **lowest maintenance costs**
- **minimum total life cycle costs by high reliability**
- **packaging in crates offers the maximum protection during shipping and storage**

Production and Product Tables

PPC Insulators production facilities for IEC station post insulators manufacture in full accordance to IEC60273. Operating rod columns for disconnectors are manufactured corresponding to the relevant post insulators.

Insulation requirements are available in ratings from BIL 60 kV to 2550 kV.
This catalogue includes standard IEC solid core station post insulators with external metal fittings. Insulator creepage distances are in accordance with IEC60273 and IEC60815. Special requirements, such as other creepage distances, special shed forms, other top bending moments or pitch circle diameters, can also be offered upon request

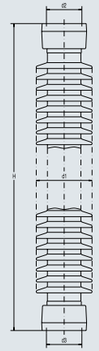
Conversion Table

Dimensions	1	mm	0.03937	inch
	25.4	mm	1	inch
Force	1	N	0.22481	pound
	4.448	N	1	pound
Moment of Force	1	Nm	8.8508	inch-pound
	0.113	Nm	1	inch-pound

Solid Core Post Insulators

Type BIL 60-95 kV

Porcelain C 130 (or C 120) according to IEC60672-3
Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



IEC POST INSULATOR DESIGNATION	C4-60	C6-60	C8-60	C10-60
Dimensions				
Height H [mm]	190 ± 1	190 ± 1	190 ± 1	190 ± 1
Max. nom. diameter of insulating part d1 [mm]	170	170	180	180
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Mechanical Values				
Minimum failing load - Bending [kN]	4	6	8	10
Minimum failing load - Bending moment underhung [kNm]	0.38	0.57	0.76	0.95
Minimum failing load - Bending moment upright [kNm]	0.76	1.14	1.52	1.9
Minimum failing load - Torsion [kNm]	0.6	0.6	0.8	1
Electrical Values				
Lightning impulse withstand voltage, dry [kV peak value]	60	60	60	60
Power frequency withstand voltage, wet [kV r.m.s.]	20	20	20	20

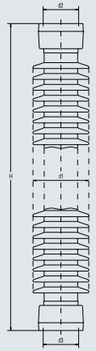
IEC POST INSULATOR DESIGNATION	C4-75	C6-75	C8-75	C10-75
Dimensions				
Height H [mm]	215 ± 1	215 ± 1	215 ± 1	215 ± 1
Max. nom. diameter of insulating part d1 [mm]	150	150	165	165
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Mechanical Values				
Minimum failing load - Bending [kN]	4	6	8	10
Minimum failing load - Bending moment underhung [kNm]	0.43	0.65	0.86	1.08
Minimum failing load - Bending moment upright [kNm]	0.86	1.29	1.72	2.15
Minimum failing load - Torsion [kNm]	0.6	0.6	0.8	1
Electrical Values				
Lightning impulse withstand voltage, dry [kV peak value]	75	75	75	75
Power frequency withstand voltage, wet [kV r.m.s.]	28	28	28	28

IEC POST INSULATOR DESIGNATION	C4-95	C6-95	C8-95	C10-95	C12.5-95
Dimensions					
Height H [mm]	255 ± 1	255 ± 1	255 ± 1	255 ± 1	255 ± 1
Max. nom. diameter of insulating part d1 [mm]	150	155	165	170	180
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	0.51	0.77	1.02	1.28	1.6
Minimum failing load - Bending moment upright [kNm]	1.02	1.53	2.04	2.55	3.19
Minimum failing load - Torsion [kNm]	0.8	0.8	1.2	1.2	1.8
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	95	95	95	95	95
Power frequency withstand voltage, wet [kV r.m.s.]	38	38	38	38	38

Solid Core Post Insulators

Type BIL 125-170 kV

Porcelain C 130 (or C 120) according to IEC60672-3
Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



IEC POST INSULATOR DESIGNATION	C4-125	C6-125	C8-125	C10-125	C12.5-125
Dimensions					
Height H [mm]	305 ± 1	305 ± 1	305 ± 1	305 ± 1	305 ± 1
Max. nom. diameter of insulating part d1 [mm]	170	180	190	190	200
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	0.61	0.92	1.22	1.53	1.91
Minimum failing load - Bending moment upright [kNm]	1.22	1.83	2.44	3.05	3.82
Minimum failing load - Torsion [kNm]	0.8	0.8	1.2	1.2	2
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	125	125	125	125	125
Power frequency withstand voltage, wet [kV r.m.s.]	50	50	50	50	50

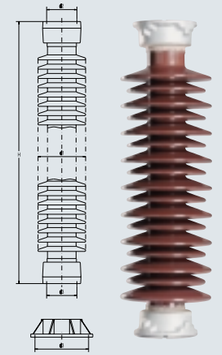
IEC POST INSULATOR DESIGNATION	C4-150	C6-150	C8-150	C10-150	C12.5-150
Dimensions					
Height H [mm]	355 ± 1	355 ± 1	355 ± 1	355 ± 1	355 ± 1
Max. nom. diameter of insulating part d1 [mm]	175	190	190	195	205
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	76/4x M12
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	0.71	1.07	1.42	1.78	2.22
Minimum failing load - Bending moment upright [kNm]	1.42	2.13	2.84	3.55	4.44
Minimum failing load - Torsion [kNm]	1	1.2	1.5	1.8	2.5
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	150	150	150	150	150
Power frequency withstand voltage, wet [kV r.m.s.]	50	50	50	50	50

IEC POST INSULATOR DESIGNATION	C4-170	C6-170	C8-170	C10-170	C12.5-170
Dimensions					
Height H [mm]	445 ± 1	445 ± 1	445 ± 1	445 ± 1	445 ± 1
Max. nom. diameter of insulating part d1 [mm]	180	190	195	205	210
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	127/4x M16
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	0.89	1.34	1.78	2.23	2.79
Minimum failing load - Bending moment upright [kNm]	1.78	2.67	3.56	4.45	5.57
Minimum failing load - Torsion [kNm]	1.2	1.5	2	2.5	3
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	170	170	70	170	170
Power frequency withstand voltage, wet [kV r.m.s.]	70	70	70	70	70

Solid Core Post Insulators

Type BIL 200-325 kV

Porcelain C 130 (or C 120) according to IEC60672-3
Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



IEC POST INSULATOR DESIGNATION	C4-200	C6-200	C8-200	C10-200	C12.5-200
Dimensions					
Height H [mm]	475 ± 1	475 ± 1	475 ± 1	475 ± 1	475 ± 1
Max. nom. diameter of insulating part d1 [mm]	180	190	200	205	215
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12	76/4x M12	76/4x M12	76/4x M12	127/4x M16
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	0.95	1.43	1.9	2.38	2.97
Minimum failing load - Bending moment upright [kNm]	1.9	2.85	3.8	4.75	5.94
Minimum failing load - Torsion [kNm]	1.2	1.8	2	2.5	3
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	200	200	200	200	200
Power frequency withstand voltage, wet [kV r.m.s.]	70	70	70	70	70

IEC POST INSULATOR DESIGNATION	C4-250	C6-250	C8-250	C10-250	C12.5-250
Dimensions					
Height H [mm]	560 ± 1	560 ± 1	560 ± 1	560 ± 1	560 ± 1
Max. nom. diameter of insulating part d1 [mm]	175	185	200	200	200
Top fitting p.c.d. d2 [mm] / hole pattern	76/4x M12 127/4x M16	76/4x M12 127/4x M16	127/4x M16	127/4x M16	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	76/4x M12 127/4x M16	76/4x M12 127/4x M16	127/4x M16	127/4x M16	127/4x M16
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	1.12	1.68	2.24	2.8	3.5
Minimum failing load - Bending moment upright [kNm]	2.24	3.36	4.48	5.6	7
Minimum failing load - Torsion [kNm]	1.8	2	2.5	3	4
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	250	250	250	250	250
Power frequency withstand voltage, wet [kV r.m.s.]	95	95	95	95	95

IEC POST INSULATOR DESIGNATION	C2-325	C4-325	C6-325	C8-325	C10-325	C12.5-325	C16-325	C20-325
Dimensions								
Height H [mm]	770 ± 1	770 ± 1	770 ± 1	770 ± 1	770 ± 1	770 ± 1	770 ± 1	770 ± 1
Max. nom. diameter of insulating part d1 [mm]	165	185	195	205	210	220	230	240
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	225/4x18	254/8x18
Mechanical Values								
Min. failing load - Bending [kN]	2	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	0.77	1.54	2.31	3.08	3.85	4.82	6.16	7.7
Min. failing load - Bending moment upright [kNm]	1.54	3.08	4.62	6.16	7.7	9.63	12.32	15.4
Min. failing load - Torsion [kNm]	1.2	2	2.5	3	4	4	5	6
Electrical Values								
Lightn. impulse withst. voltage, dry [kV peak value]	325	325	325	325	325	325	325	325
Power frequency withst. voltage, wet [kV r.m.s.]	140	140	140	140	140	140	140	140

Solid Core Post Insulators

Type BIL 450-650 kV

IEC POST INSULATOR DESIGNATION	C2-450	C4-450	C6-450	C8-450	C10-450	C12.5-450	C16-450	C20-450
Dimensions								
Height H [mm]	1020 ± 1	1020 ± 1	1020 ± 1	1020 ± 1	1020 ± 1	1020 ± 1	1020 ± 1	1020 ± 1
Max. nom. diameter of insulating part d1 [mm]	175	190	205	215	225	230	245	265
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	127/4x M16	127/4x M16 178/4x18	127/4x M16 178/4x18	127/4x M16 200/4x18	127/4x M16 225/4x18	225/4x18	254/8x18	254/8x18
Mechanical Values								
Min. failing load - Bending [kN]	2	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.02	2.04	3.06	4.08	5.1	6.38	8.16	10.2
Min. failing load - Bending moment upright [kNm]	2.04	4.08	6.12	8.16	10.2	12.75	16.32	20.4
Min. failing load - Torsion [kNm]	1.8	2.5	3.5	4	4	6	6	6
Electrical Values								
Lightn. impulse withst. voltage, dry [kV peak value]	450	450	450	450	450	450	450	450
Power frequency withst. voltage, wet [kV r.m.s.]	185	185	185	185	185	185	185	185

IEC POST INSULATOR DESIGNATION	C2-550	C4-550	C6-550	C8-550	C10-550	C12.5-550	C16-550	C20-550
Dimensions								
Height H [mm]	1220 ± 1	1220 ± 1	1220 ± 1	1220 ± 1	1220 ± 1	1220 ± 1	1220 ± 1	1220 ± 1
Max. nom. diameter of insulating part d1 [mm]	175	195	210	220	230	240	250	265
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16	127/4x M16
Bottom fitting p.c.d. d3 [mm] / hole pattern	127/4x M16	127/4x M16 178/4x18	127/4x M16 200/4x18	127/4x M16 200/4x18	127/4x M16 225/4x18	254/8x18	254/8x18	275/8x18
Mechanical Values								
Min. failing load - Bending [kN]	2	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.22	2.44	3.66	4.88	6.1	7.63	9.76	12.2
Min. failing load - Bending moment upright [kNm]	2.44	4.88	7.32	9.76	12.2	15.25	19.52	24.4
Min. failing load - Torsion [kNm]	2	3	4	4	4	6	6	6
Electrical Values								
Lightn. impulse withst. voltage, dry [kV peak value]	550	550	550	550	550	550	550	550
Power frequency withst. voltage, wet [kV r.m.s.]	230	230	230	230	230	230	230	230

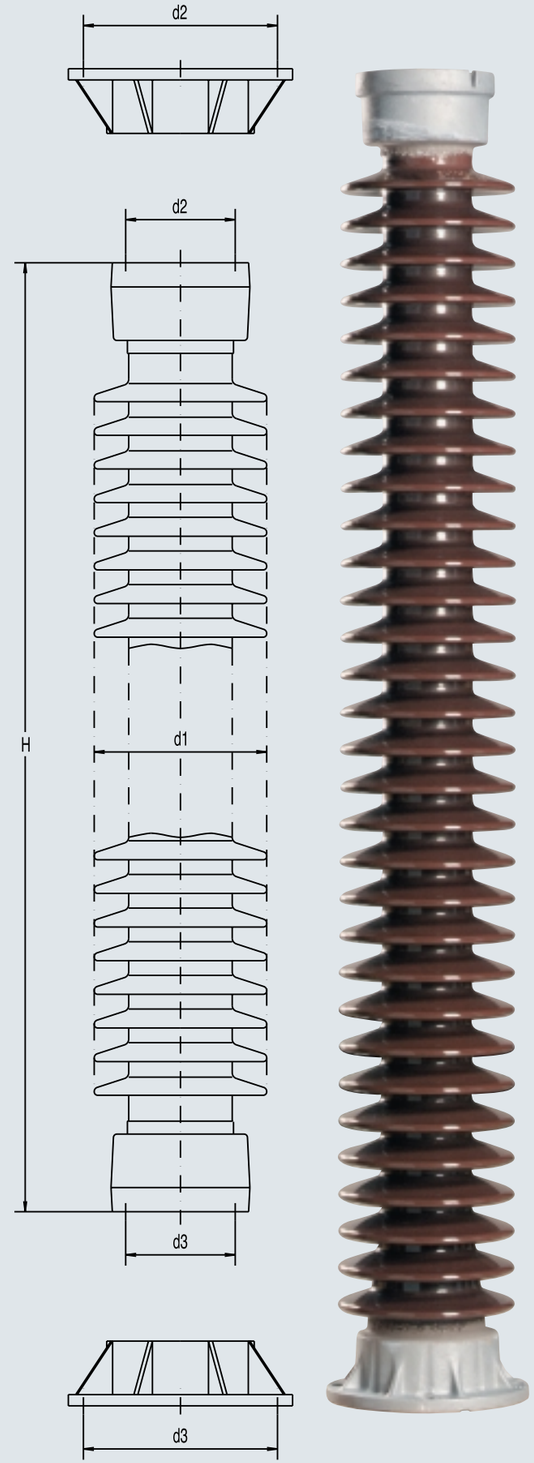
IEC POST INSULATOR DESIGNATION	C2-650	C4-650	C6-650	C8-650	C10-650	C12.5-650	C16-650	C20-650
Dimensions								
Height H [mm]	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5	1500 ± 2.5
Max. nom. diameter of insulating part d1 [mm]	170	195	210	220	230	240	250	265
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	225/4x18	225/4x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	127/4x M16 178/4x18	127/4x M16 200/4x18	127/4x M16 200/4x18	127/4x M16 225/4x18	254/8x18	254/8x18	275/8x18	300/8x18
Mechanical Values								
Min. failing load - Bending [kN]	2	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.5	3	4.5	6	7.5	9.33	12	15
Min. failing load - Bending moment upright [kNm]	3	6	9	12	15	18.75	24	30
Min. failing load - Torsion [kNm]	2	3	3	4	4	6	6	6
Electrical Values								
Lightn. impulse withst. voltage, dry [kV peak value]	650	650	650	650	650	650	650	650
Power frequency withst. voltage, wet [kV r.m.s.]	275	275	275	275	275	275	275	275

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed

Tolerance according to IEC60168

Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461

Cementing Portland (or sulfur) cement



Solid Core Post Insulators

Type BIL 750-950 kV

IEC POST INSULATOR DESIGNATION	C2-750	C4-750	C6-750	C8-750	C10-750	C12.5-750	C16-750	C20-750
Dimensions								
Height H [mm]	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5	1700 ± 2.5
Max. nom. diameter of insulating part d1 [mm]	225	225	245	255	265	280	290	305
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	127/4x M16 178/4x18	127/4x M16 200/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	254/8x18	254/8x18	275/8x18	300/8x18
Mechanical Values								
Min. failing load - Bending [kN]	2	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	0.68	1.36	2.04	2.72	3.4	4.25	5.44	6.8
Min. failing load - Bending moment upright [kNm]	3.4	6.8	10.2	13.6	17	21.25	27.2	34
Min. failing load - Torsion [kNm]	2	3	3	4	4	6	6	6
Electrical Values								
Lightn. impulse withst. voltage, dry [kV peak value]	750	750	750	750	750	750	750	750
Power frequency withst. voltage, wet [kV r.m.s.]	325	325	325	325	325	325	325	325

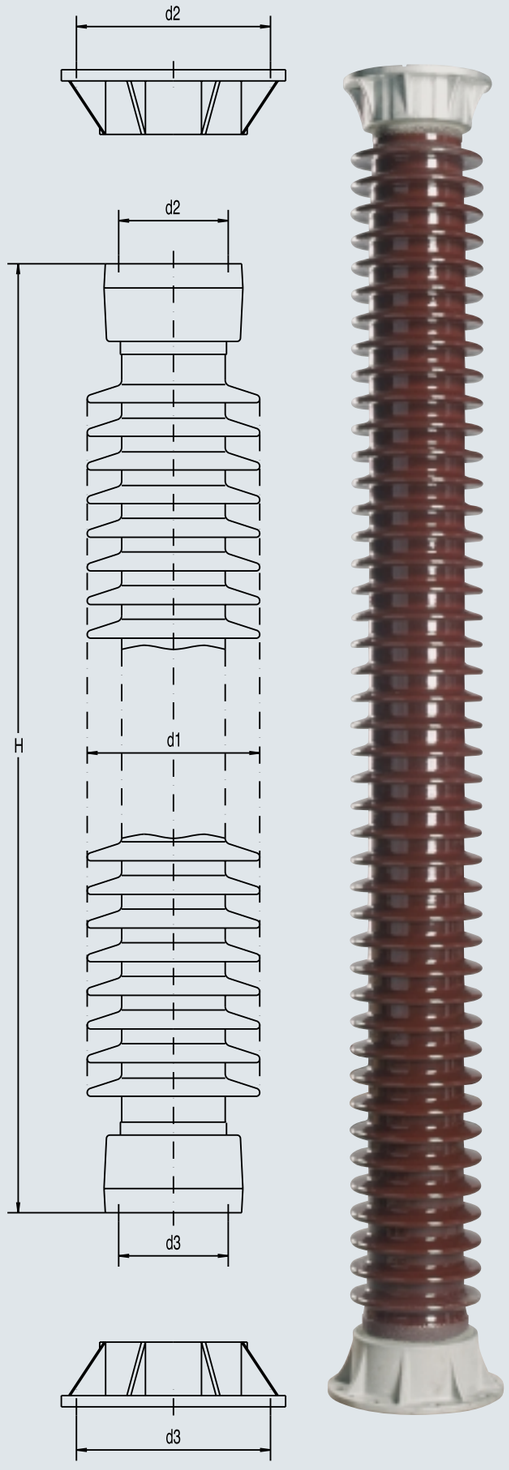
IEC POST INSULATOR DESIGNATION	C4-850	C6-850	C8-850	C10-850	C12.5-850	C16-850	C20-850
Dimensions							
Height H [mm]	1900 ± 3.5	1900 ± 3.5	1900 ± 3.5	1900 ± 3.5	1900 ± 3.5	1900 ± 3.5	1900 ± 3.5
Max. nom. diameter of insulating part d1 [mm]	230	245	260	270	280	295	310
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	200/4x18	225/4x18	254/8x18	254/8x18	254/8x18	275/8x18	300/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.52	2.28	3.04	3.8	4.75	6.08	7.6
Min. failing load - Bending moment upright [kNm]	7.6	11.4	15.2	19	23.75	30.4	38
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	850	850	850	850	850	850	850
Power frequency withst. voltage, wet [kV r.m.s.]	360	360	360	360	360	360	360

Will be offered as one or two unit column

IEC POST INSULATOR DESIGNATION	C4-950	C6-950	C8-950	C10-950	C12.5-950	C16-950	C20-950
Dimensions							
Height H [mm]	2100 ± 3.5	2100 ± 3.5	2100 ± 3.5	2100 ± 3.5	2100 ± 3.5	2100 ± 3.5	2100 ± 3.5
Max. nom. diameter of insulating part d1 [mm]	225	245	255	270	285	295	310
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	200/4x18	225/4x18	254/8x18	254/8x18	275/8x18	300/8x18	325/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.68	2.52	3.36	4.2	5.25	6.72	8.4
Min. failing load - Bending moment upright [kNm]	8.4	12.6	16.8	21	26.25	33.6	42
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	950	950	950	950	950	950	950
Switching impulse withstand voltage, wet [kV peak value]	750	750	750	750	750	750	750
Power frequency withst. voltage, wet [kV r.m.s.]	395	395	395	395	395	395	395

Will be offered as one or two unit column

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



Solid Core Post Insulators

Type BIL 1050-1300 kV

Will be offered as one or two unit column

IEC POST INSULATOR DESIGNATION	C4-1050	C6-1050	C8-1050	C10-1050	C12.5-1050	C16-1050	C20-1050
Dimensions							
Height H [mm]	2300 ± 3.5	2300 ± 3.5	2300 ± 3.5	2300 ± 3.5	2300 ± 3.5	2300 ± 3.5	2300 ± 3.5
Max. nom. diameter of insulating part d1 [mm]	245	260	270	280	295	310	325
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	200/4x18	225/4x18	254/8x18	275/8x18	275/8x18	300/8x18	325/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	1.84	2.76	3.68	4.6	5.75	7.36	9.2
Min. failing load - Bending moment upright [kNm]	9.2	13.8	18.4	23	28.75	36.8	46
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	1050	1050	1050	1050	1050	1050	1050
Switching impulse withstand voltage, wet [kV peak value]	750	750	750	750	750	750	750
Power frequency withst. voltage, wet [kV r.m.s.]	460	460	460	460	460	460	460

Will be offered as two unit column

IEC POST INSULATOR DESIGNATION	C4-1175	C6-1175	C8-1175	C10-1175	C12.5-1175	C16-1175	C20-1175
Dimensions							
Height H [mm]	2650 ± 4.5	2650 ± 4.5	2650 ± 4.5	2650 ± 4.5	2650 ± 4.5	2650 ± 4.5	2650 ± 4.5
Max. nom. diameter of insulating part d1 [mm]	235	250	265	280	290	310	325
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	225/4x18	254/8x18	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	2.12	3.18	4.24	5.3	6.63	8.48	10.6
Min. failing load - Bending moment upright [kNm]	10.6	15.9	21.2	26.5	33.13	42.4	53
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	1175	1175	1175	1175	1175	1175	1175
Switching impulse withstand voltage, wet [kV peak value]	850	850	850	850	850	850	850

Will be offered as two unit column

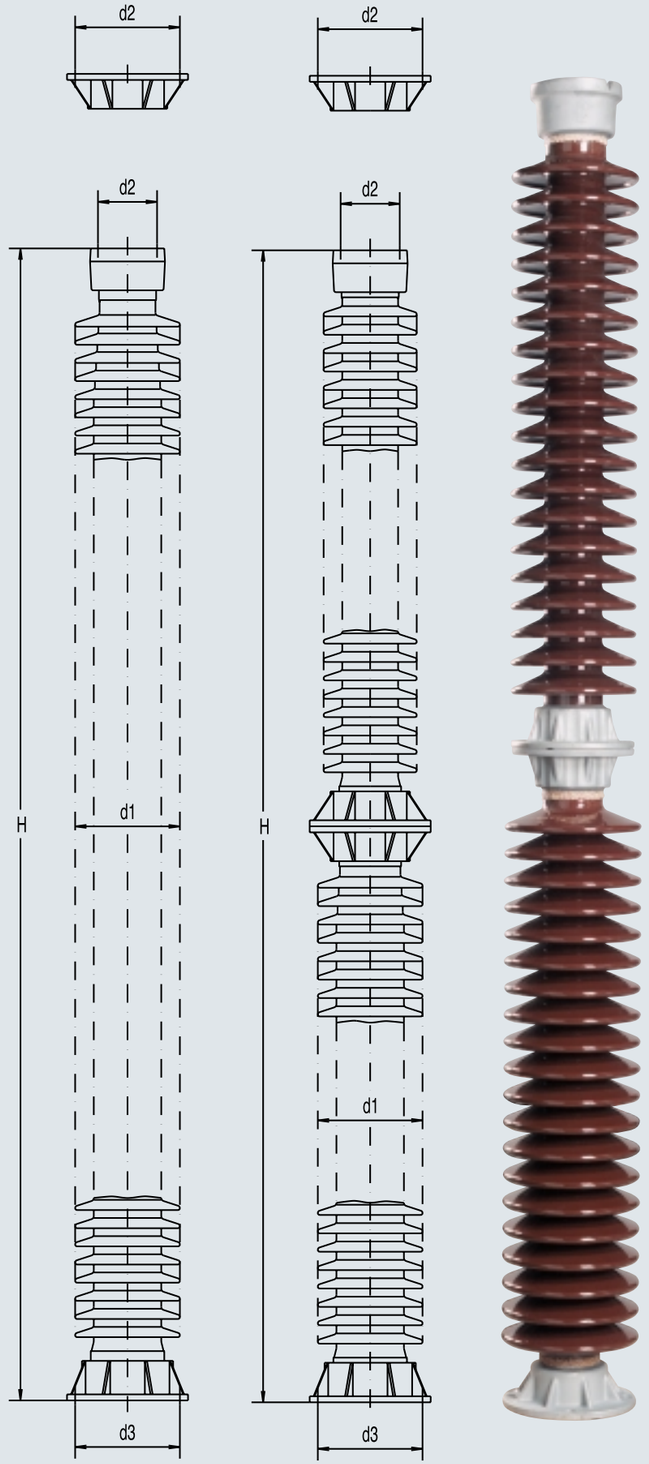
IEC POST INSULATOR DESIGNATION	C4-1300	C6-1300	C8-1300	C10-1300	C12.5-1300	C16-1300	C20-1300
Dimensions							
Height H [mm]	2900 ± 4.5	2900 ± 4.5	2900 ± 4.5	2900 ± 4.5	2900 ± 4.5	2900 ± 4.5	2900 ± 4.5
Max. nom. diameter of insulating part d1 [mm]	250	270	280	295	310	325	325
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	225/4x18	254/8x18	275/8x18	275/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	2.32	3.48	4.64	5.8	7.25	9.28	11.6
Min. failing load - Bending moment upright [kNm]	11.6	17.4	23.2	29	36.25	46.4	58
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	1300	1300	1300	1300	1300	1300	1300
Switching impulse withstand voltage, wet [kV peak value]	950	950	950	950	950	950	950

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed

Tolerance according to IEC60168

Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461

Cementing Portland (or sulfur) cement



Solid Core Post Insulators

Type BIL 1425-1675 kV

IEC POST INSULATOR DESIGNATION	C4-1425	C6-1425	C8-1425	C10-1425	C12.5-1425	C16-1425	C20-1425
Dimensions							
Height H [mm]	3150 ± 4.5	3150 ± 4.5	3150 ± 4.5	3150 ± 4.5	3150 ± 4.5	3150 ± 4.5	3150 ± 4.5
Max. nom. diameter of insulating part d1 [mm]	260	280	290	310	325	325	330
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	225/4x18	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18	356/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	2.52	3.78	5.04	6.3	7.88	10.08	12.6
Min. failing load - Bending moment upright [kNm]	12.6	18.9	25.2	31.5	39.38	50.4	63
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	1425	1425	1425	1425	1425	1425	1425
Switching impulse withstand voltage, wet [kV peak value]	950	950	950	950	950	950	950

Will be offered as two unit column

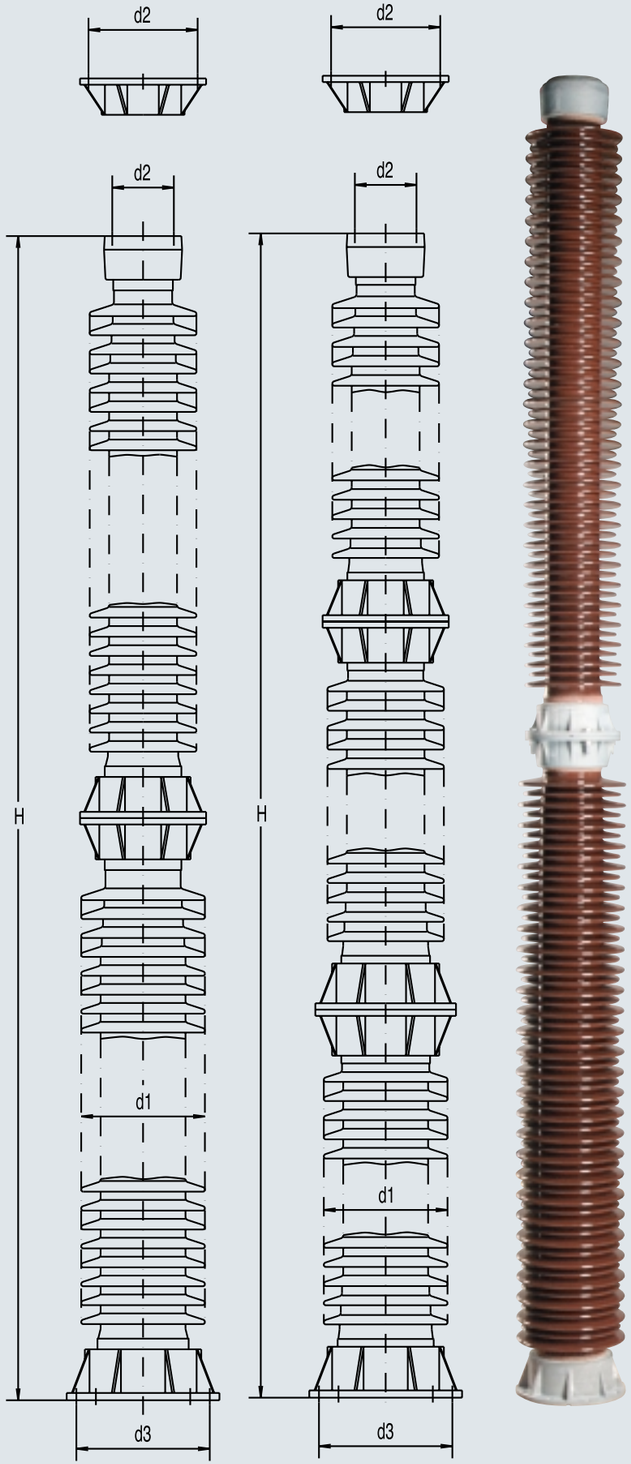
IEC POST INSULATOR DESIGNATION	C4-1550	C6-1550	C8-1550	C10-1550	C12.5-1550	C16-1550	C20-1550
Dimensions							
Height H [mm]	3350 ± 4.5	3350 ± 4.5	3350 ± 4.5	3350 ± 4.5	3350 ± 4.5	3350 ± 4.5	3350 ± 4.5
Max. nom. diameter of insulating part d1 [mm]	260	280	300	310	325	325	330
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	225/4x18	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18	356/8x18
Mechanical Values							
Min. failing load - Bending [kN]	4	6	8	10	12.5	16	20
Min. failing load - Bending moment underhung [kNm]	2.68	4.02	5.36	6.7	8.38	10.72	13.4
Min. failing load - Bending moment upright [kNm]	13.4	20.1	26.8	33.5	41.88	53.6	67
Min. failing load - Torsion [kNm]	3	3	4	4	6	6	6
Electrical Values							
Lightn. impulse withst. voltage, dry [kV peak value]	1550	1550	1550	1550	1550	1550	1550
Switching impulse withstand voltage, wet [kV peak value]	1050	1050	1050	1050	1050	1050	1050

Will be offered as two unit column

IEC POST INSULATOR DESIGNATION	C4-1675	C6-1675	C8-1675	C10-1675	C12.5-1675	C16-1675
Dimensions						
Height H [mm]	3650 ± 5.5	3650 ± 5.5	3650 ± 5.5	3650 ± 5.5	3650 ± 5.5	3650 ± 5.5
Max. nom. diameter of insulating part d1 [mm]	270	275	300	315	330	330
Top fitting p.c.d. d2 [mm] / hole pattern	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	127/4x M16 225/4x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	275/8x18	300/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values						
Min. failing load - Bending [kN]	4	6	8	10	12.5	16
Min. failing load - Bending moment underhung [kNm]	2.92	4.38	5.84	7.3	9.13	11.68
Min. failing load - Bending moment upright [kNm]	14.6	21.9	29.2	36.5	45.63	58.4
Min. failing load - Torsion [kNm]	3	3	4	4	6	6
Electrical Values						
Lightn. impulse withst. voltage, dry [kV peak value]	1675	1675	1675	1675	1675	1675
Switching impulse withstand voltage, wet [kV peak value]	1050	1050	1050	1050	1050	1050

Will be offered as two or three unit column

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



Solid Core Post Insulators

Type BIL 1800-2100 kV

IEC POST INSULATOR DESIGNATION	C4-1800	C6-1800	C8-1800	C10-1800	C12.5-1800	C16-1800
Dimensions						
Height H [mm]	4000 ± 5.5	4000 ± 5.5	4000 ± 5.5	4000 ± 5.5	4000 ± 5.5	4000 ± 5.5
Max. nom. diameter of insulating part d1 [mm]	260	280	300	320	320	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18	356/8x18
Mechanical Values						
Min. failing load - Bending [kN]	4	6	8	10	12.5	16
Min. failing load - Bending moment underhung [kNm]	3.2	4.8	6.4	8	10	12.8
Min. failing load - Bending moment upright [kNm]	16	24	32	40	50	64
Min. failing load - Torsion [kNm]	3	3	4	4	6	6
Electrical Values						
Lightn. impulse withst. voltage, dry [kV peak value]	1800	1800	1800	1800	1800	1800
Switching impulse withstand voltage, wet [kV peak value]	1175	1175	1175	1175	1175	1175

Will be offered as two or three unit column

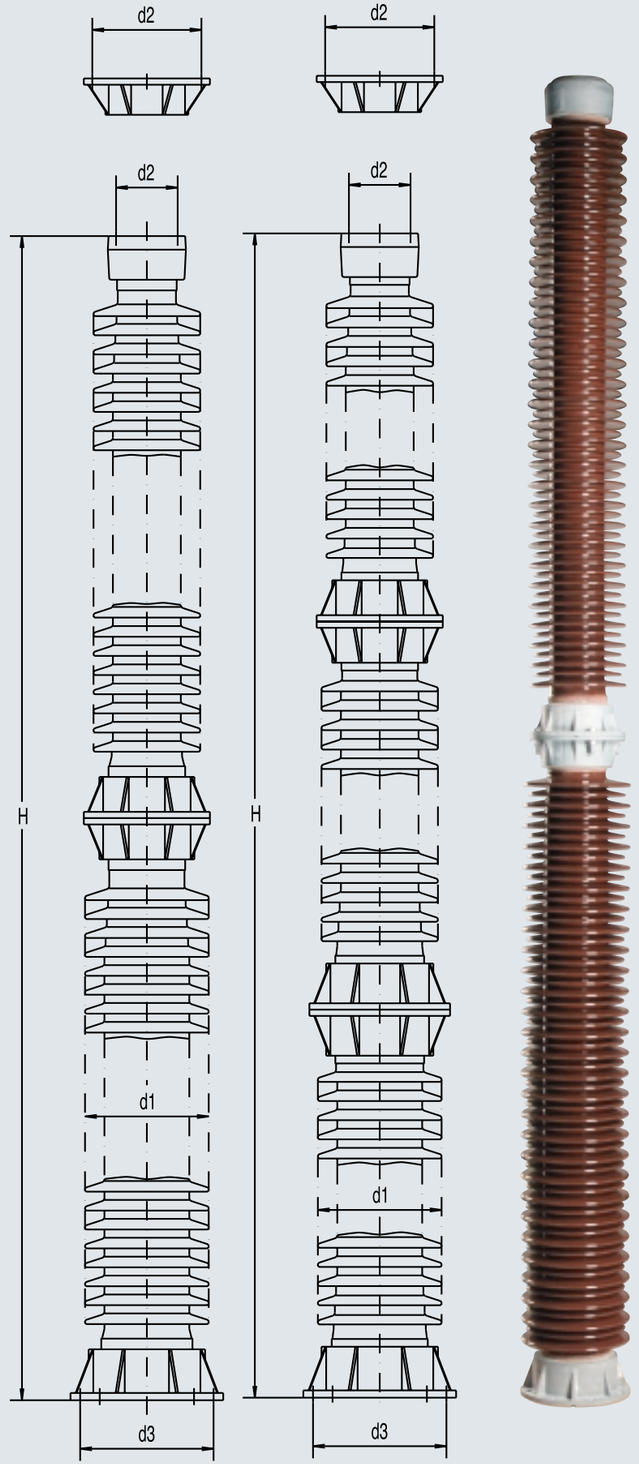
IEC POST INSULATOR DESIGNATION	C4-1950	C6-1950	C8-1950	C10-1950	C12.5-1950
Dimensions					
Height H [mm]	4400 ± 5.5	4400 ± 5.5	4400 ± 5.5	4400 ± 5.5	4400 ± 5.5
Max. nom. diameter of insulating part d1 [mm]	270	300	310	330	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	3.52	5.28	7.04	8.8	11
Minimum failing load - Bending moment upright [kNm]	17.6	26.4	35.2	44	55
Minimum failing load - Torsion [kNm]	3	3	4	4	6
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	1950	1950	1950	1950	1950
Switching impulse withstand voltage, wet [kV peak value]	1300	1300	1300	1300	1300

Will be offered as two or three unit column

IEC POST INSULATOR DESIGNATION	C4-2100	C6-2100	C8-2100	C10-2100	C12.5-2100
Dimensions					
Height H [mm]	4700 ± 5.5	4700 ± 5.5	4700 ± 5.5	4700 ± 5.5	4700 ± 5.5
Max. nom. diameter of insulating part d1 [mm]	280	300	320	320	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	275/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	3.76	5.64	7.52	9.4	11.75
Minimum failing load - Bending moment upright [kNm]	18.8	28.2	37.6	47	58.75
Minimum failing load - Torsion [kNm]	3	3	4	4	6
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	2100	2100	2100	2100	2100
Switching impulse withstand voltage, wet [kV peak value]	1300	1300	1300	1300	1300

Will be offered as three unit column

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



Solid Core Post Insulators

Type BIL 2250-2550 kV

IEC POST INSULATOR DESIGNATION	C4-2250	C6-2250	C8-2250	C10-2250	C12.5-2250
Dimensions					
Height H [mm]	5000 ± 6.5	5000 ± 6.5	5000 ± 6.5	5000 ± 6.5	5000 ± 6.5
Max. nom. diameter of insulating part d1 [mm]	280	300	320	320	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	300/8x18	325/8x18	356/8x18	356/8x18
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	4	6	8	10	12.5
Minimum failing load - Bending moment upright [kNm]	20	30	40	50	62.5
Minimum failing load - Torsion [kNm]	3	3	4	4	6
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	2250	2250	2250	2250	2250
Switching impulse withstand voltage, wet [kV peak value]	1425	1425	1425	1425	1425

Will be offered as three unit column

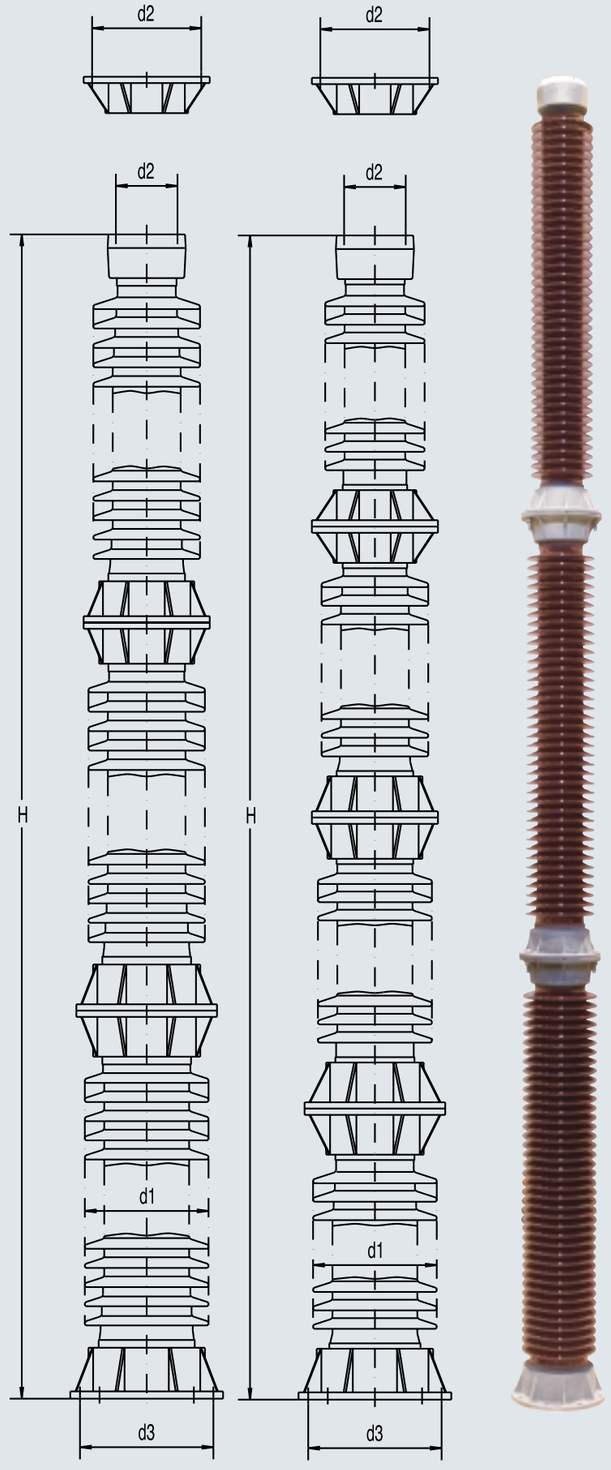
IEC POST INSULATOR DESIGNATION	C4-2400	C6-2400	C8-2400	C10-2400	C12.5-2400
Dimensions					
Height H [mm]	5300 ± 6.5	5300 ± 6.5	5300 ± 6.5	5300 ± 6.5	5300 ± 6.5
Max. nom. diameter of insulating part d1 [mm]	280	310	325	325	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	254/8x18	300/8x18	325/8x18	356/8x18	356/8x18
Mechanical Values					
Minimum failing load - Bending [kN]	4	6	8	10	12.5
Minimum failing load - Bending moment underhung [kNm]	4.24	6.36	8.48	10.6	13.25
Minimum failing load - Bending moment upright [kNm]	21.2	31.8	42.4	53	66.25
Minimum failing load - Torsion [kNm]	3	3	4	4	6
Electrical Values					
Lightning impulse withstand voltage, dry [kV peak value]	2400	2400	2400	2400	2400
Switching impulse withstand voltage, wet [kV peak value]	1425	1425	1425	1425	1425

Will be offered as three or four unit column

IEC POST INSULATOR DESIGNATION	C4-2550	C6-2550	C8-2550	C10-2550
Dimensions				
Height H [mm]	5700 ± 6.5	5700 ± 6.5	5700 ± 6.5	5700 ± 6.5
Max. nom. diameter of insulating part d1 [mm]	285	310	330	330
Top fitting p.c.d. d2 [mm] / hole pattern	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18	225/4x18 254/8x18
Bottom fitting p.c.d. d3 [mm] / hole pattern	275/8x18	300/8x18	325/8x18	356/8x18
Mechanical Values				
Minimum failing load - Bending [kN]	4	6	8	10
Minimum failing load - Bending moment underhung [kNm]	4.56	6.84	9.12	11.4
Minimum failing load - Bending moment upright [kNm]	22.8	34.2	45.6	57
Minimum failing load - Torsion [kNm]	3	3	4	4
Electrical Values				
Lightning impulse withstand voltage, dry [kV peak value]	2550	2550	2550	2550
Switching impulse withstand voltage, wet [kV peak value]	1550	1550	1550	1550

Will be offered as three or four unit column

Porcelain C 130 (or C 120) according to IEC60672-3, Brown or Munsell grey glazed
Tolerance according to IEC60168
Fittings malleable cast iron according to EN1562 or spheroidal graphite cast iron according to EN1563, hot dip galvanized according to ENISO1461
Cementing Portland (or sulfur) cement



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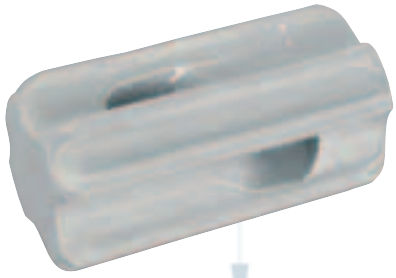
› ANSI



Today, we are still providing high-quality reliable products but our role has expanded as a world-wide supplier.

Whether you need suspension insulators, tie-top line post insulators, pin type and high voltage pin type insulators, PDEI Polymer deadend insulators, or spool and guy strain insulators, you can count on **PPC Insulators to have the widest range of T&D Insulators in the world ... when you need it!** That means "24/7", twenty-four hours a day, seven days a week.

11/16"

11/16"

11/16"

T&D Insulators.
The Best!

Index

PPC INSULATORS

T&D

Suspension Insulators

PPC Insulators standard suspension insulators with high mechanical and electrical strength are designed to meet the most modern demands of high voltage and EHV transmission line usage today.

PPC Insulators makes one of the widest ranges of ANSI approved Ball–Socket and Clevis type distribution suspension insulators for overhead distribution and transmission systems in the world.

Each suspension shell undergoes rigorous electrical testing before and after assembly before being shipped. Catalogue numbers 81022, 81012, 86012, 84300 conform to ANSI Class 52-1 through 52-9 specifications and are also REA accepted.

Tie–Top Line Post Insulators

The one – piece design utilized in **PPC** Insulators tie – top line post insulator eliminates the need for suspension shells while providing maximum protection under severe flashover and mechanical impact. Designed for upright or angle mounting on a crossarm, a choice of stud assemblies is available for both wood and steel crossarms. All Line Post Insulators are manufactured by **PPC** Insulators in strict compliance to ANSI standards.

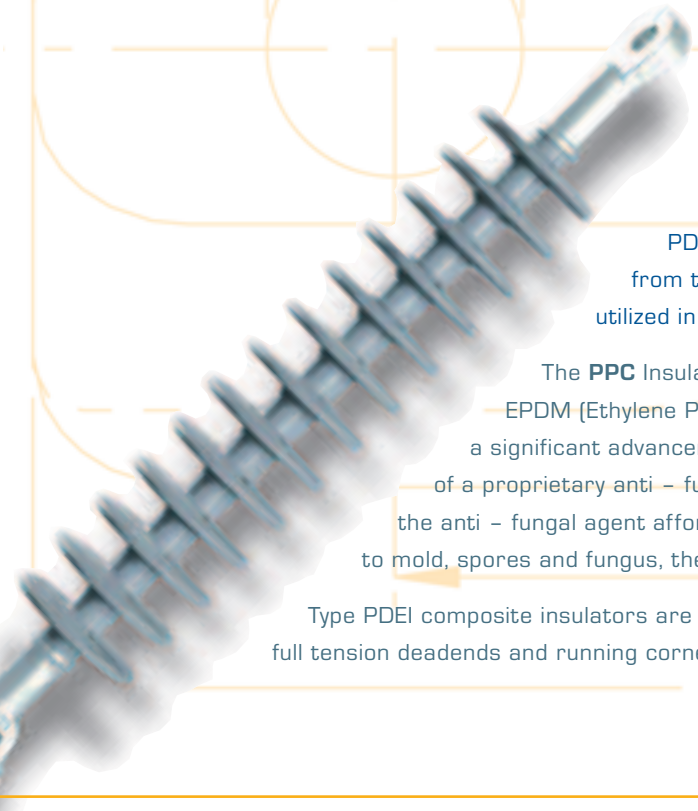
Insulators Products

Horizontal & Vertical Clamp Top Line Post

PPC Insulators offer horizontal & vertical clamp top linepost assemblies for ratings 25 kV through 35 kV.

PPC horizontal mounting line post assemblies are primarily recommended for downleads, jumper loop control and similar applications. A galvanized metal cap is cemented to the outside of the line post head supporting the trunnion type clamp.

PPC vertical clamp top line post insulators are mounted upright on crossarms and structures. Rated at 2800 lb. cantilever strength these insulators offer strength with excellent mechanical as well as electrical characteristics.



PDEI Polymer Deadend Insulators

PDEI composite insulators are manufactured from two base compounds; silicone, the type most often utilized in highly contaminating areas, and EPDM.

The **PPC** Insulators EPDM version has evolved from the original formulation, EPDM (Ethylene Propylene Diamer Modified), into a formulation representing a significant advancement; the development and addition of a proprietary anti – fungal agent. Since EPDM is an organic compound, the anti – fungal agent affords the industry an insulator with superior resistance to mold, spores and fungus, thereby insuring product longevity.

Type PDEI composite insulators are designed for distribution line suspension, full tension deadends and running corners with maximum high design loads.

T&D Insulators

PinType Insulators

Highly resistant to lightning puncture, **PPC** Insulators manufactures a wide range of low and high voltage PinType Insulators designed for distribution and sub transmission circuits. The versatile neck designs in "C, F, K and J," side and top grooves, allow the acceptance of large – diameter conductors to permit easy tying. All neck sizes conform to industry standards allowing factory – formed ties to be used.

Pin Post Insulators

PPC Insulators alternative design offers users the unique advantage of reducing inventory by using the pin type insulator as a line post insulator. The primary advantage of the pin post insulator is really the advantage of better operating characteristics to line post insulators without changing the hardware.

PPC's thimble design ensures the highest strength and is tested for integrity prior to assembly.

Products

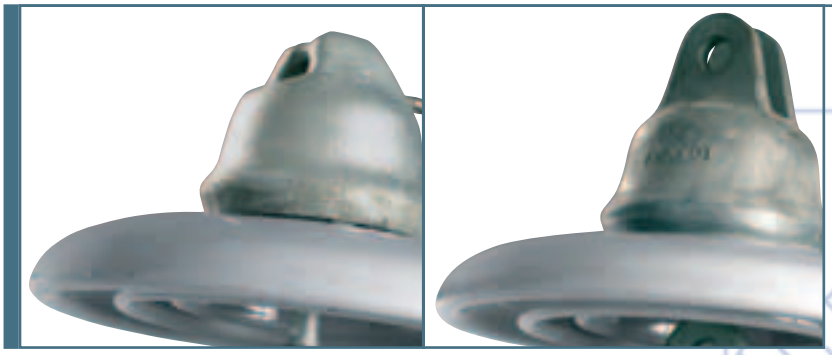
Spool and Guy Strains

PPC Insulators makes spool and guy strain insulators out of the highest grade electrical wet-process porcelain in a wide range of electrical values and all resistant to mechanical breakage.

Strength ratings are made in accordance with ANSI Standard C29.4 for ultimate strength.

T&D Insulators Product

Hardware



ball & socket coupling

clevis-eye coupling

Suspension insulators are available for ball & socket or clevis-eye coupling. Standard caps are constructed of hot-dip galvanized malleable iron. Cotter keys for locking ball & socket and clevis pin connections are stainless steel.

Cementing

Caps, ball bolts and eyebolts are cemented on to the porcelain, loading the porcelain in a large area, low intensity compression grip. **PPC** Insulators utilizes a special Portland cement, particularly suited for use on porcelain insulator assemblies.

Hardware Coating

Prior to cementing, all hardware surfaces in contact with cement are coated with a bituminous (asphalt) compound. The compound protects the hardware from chemical attack by the cement and provides thermal movement between parts to relieve mechanical stress created by thermal movement or cement growth.

Features

Bonded Sand Bands

Sand bands bonded to the porcelain by glaze provide a rough surface for permanently attaching the hardware and distributing loading evenly through the porcelain. The high strength compression sand is manufactured by **PPC** Insulators to match the characteristics of the porcelain body.

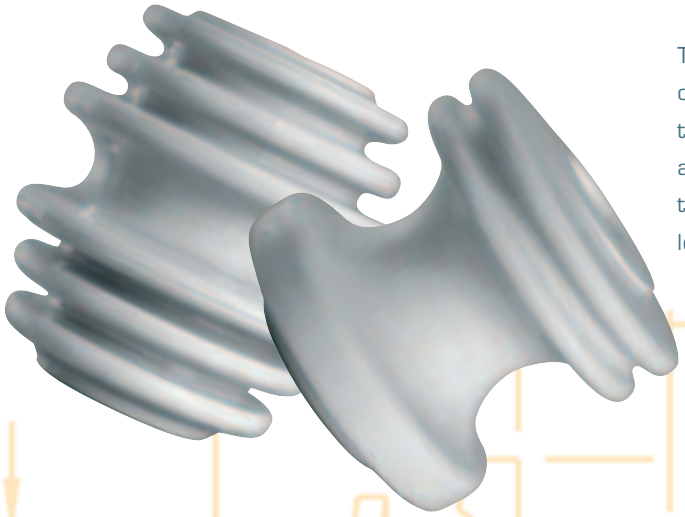
Porcelain Body

PPC transmission and distribution insulators are constructed of high quality electrical grade porcelain.

Each porcelain body receives a series of electrical tests prior to assembly. 100% of all bodies are subjected to high frequency puncture tests thereby insuring soundness and performance prior to assembly. This same test, in addition to other prescribed ANSI tests, are performed once again after assembly insuring the integrity of the porcelain and the assembled product.

T&D Insulators Product

Protected Leakage Configuration



The umbrella type spreading porcelain shell or shed protects the leakage corrugations on the underside of the insulator from contamination and mechanical damage. The sheds are designed to provide optimum normal and protected leakage distance in relation to size and shape.

Forged Steel Eye & Ball Bolts

PPC Insulators utilizes hot dip galvanized forged steel for the ball bolt and the eyebolt. Standard production of suspension insulators incorporates a pregnant bolt design for both ball & socket and clevis type units. The extra mass of the pregnant bolt design plus the compound coating provides corrosion protection at the cement line caused by ozone, electrolytic action and other factors. A zinc sleeve may also be supplied on a straight bolt, for corrosion protection, when specified.

Interference Free

PPC Insulators suspension insulators are radio & television interference free by design and have been completely tested, both individually and as assemblies. Our hardware is smooth contoured with well-rounded edges to reduce RIV build-up and does not require corona rings.

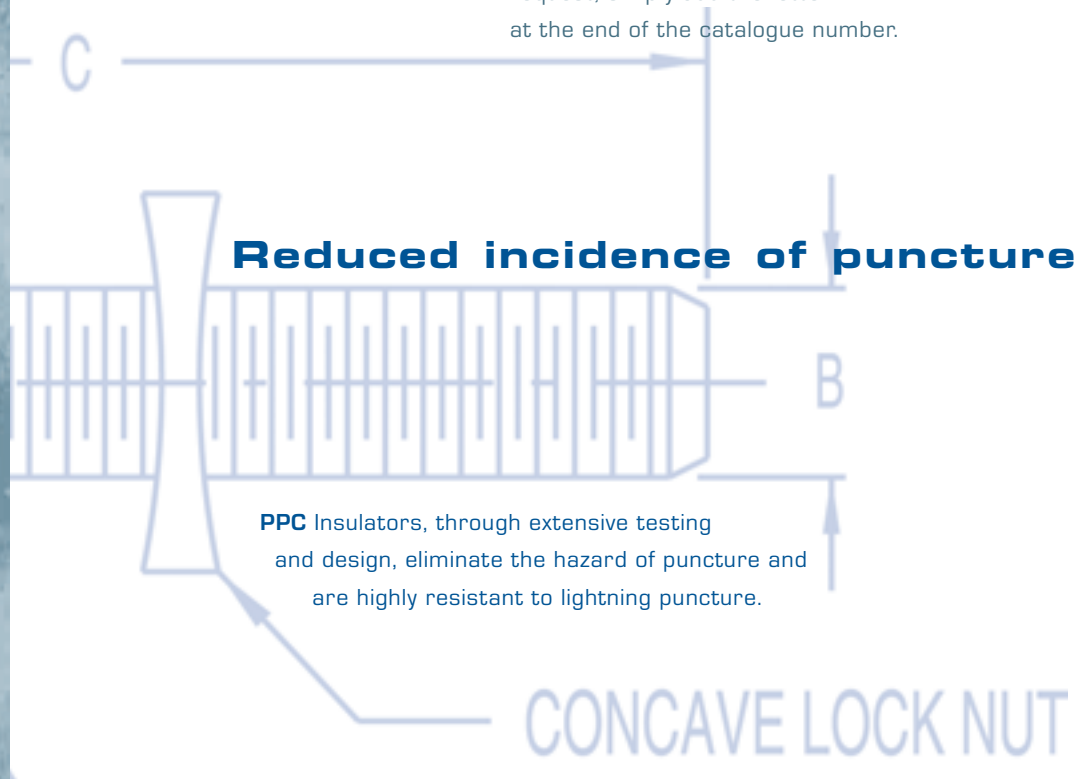
Features

Glaze

Skyline gray glaze
(ANSI – 70, Munsell 5BG 7.0/0.4)
is supplied as standard on all **PPC**
suspension insulators unless
otherwise specified.

Brown glaze is also available upon
request; simply add the letter "B"
at the end of the catalogue number.

Reduced incidence of puncture



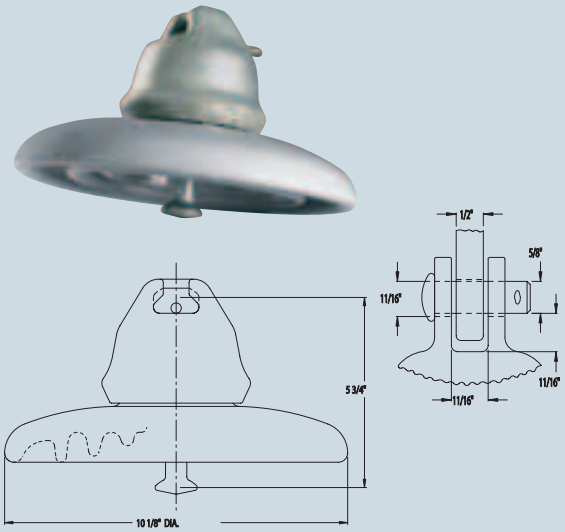
PPC Insulators, through extensive testing
and design, eliminate the hazard of puncture and
are highly resistant to lightning puncture.

T&D Insulators

Suspension Insulators

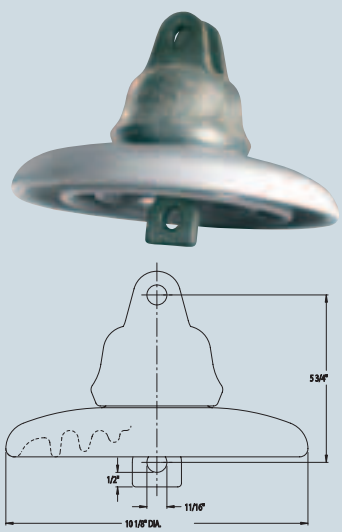
Steel Hardware

Ball-Socket



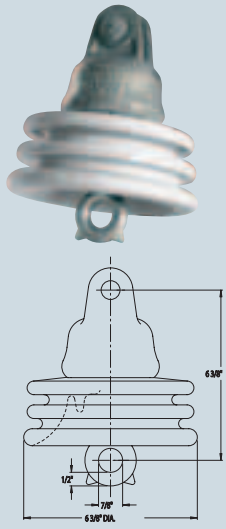
Type 81022

Clevis Type



Type 81012

Clevis Type



Type 84166

Mechanical & Electrical Characteristics

PPC Insulators Catalog Number	†81022	†81012	84166
ANSI Technical Reference Number	52-3	52-4	N/A
Dimensions			
Leakage Distance (in)/(mm)	11 1/2" 292.10 mm	11 1/2" 292.10 mm	10" 254.00 mm
Dry Arcing Distance (in)/(mm)	7 3/4" 196.85 mm	7 3/4" 196.85 mm	6" 152.40 mm
Height (in)/(mm)	5 3/4" 146.05 mm	5 3/4" 146.05 mm	6 3/8" 161.93 mm
Diameter (in)/(mm)	10 1/8" 257.18 mm	10 1/8" 257.18 mm	6 3/8" 161.93 mm
Diameter of Clevis Ring (in)/(mm)	N/A	1 1/6" 26.99 mm	1 1/6" 26.99 mm
Mechanical Values			
ANSI M & E Category	15000 lbs.	15000 lbs.	N/A
Comb. M & E Strength	20000 lbs.	20000 lbs.	10000 lbs.
Mechanical Impact Strength	55 inch lbs.	55 inch lbs.	50 inch lbs.
Routine Proof Test	10000 lbs.	10000 lbs.	5000 lbs.
Time Load Test	13200 lbs.	13200 lbs.	6000 lbs.
Electrical Values			
Low Frequency Flashover Dry	80 kV	80 kV	75 kV
Low Frequency Flashover Wet	50 kV	50 kV	40 kV
Impulse Flashover Positive	125 kV	125 kV	115 kV
Impulse Flashover Negative	130 kV	130 kV	115 kV
Low Frequency Puncture Voltage	110 kV	110 kV	90 kV
Radio Influence Low Frequency Test Voltage Data			
Test Voltage, Rms to Ground, KV	10 kV	10 kV	7.5 kV
Maximum RIV at 1000 kHz - V	50	50	50
Weight			
Maximum Net Weight	11 lbs.	11.8 lbs.	6.0 lbs.
Packaged Weight Per Unit	12.5 lbs.	13.3 lbs.	6.75 lbs.
Packaging			
Standard Packaging Quantity	6	6	8
Insulator Coatings			
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Standard	Standard	Standard

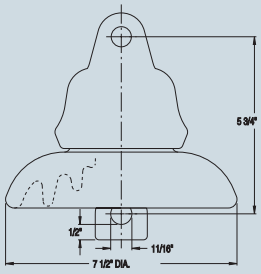
Special Glaze Requirement Upon Request † REA Accepted

T&D Insulators

Suspension Insulators

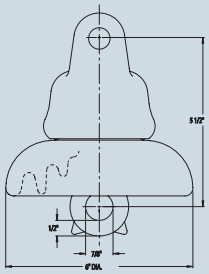
Steel Hardware

Clevis Type



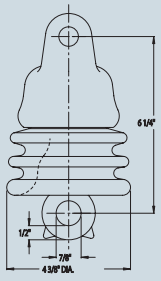
Type 87512

Clevis Type



Type 86012

Clevis Type



Type 84300

Mechanical & Electrical Characteristics

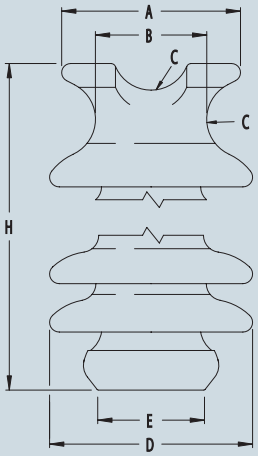
PPC Insulators Catalog Number	87512	†86012	†84300
ANSI Technical Reference Number	52-2	52-1	52-9
Dimensions			
Leakage Distance (in)/(mm)	8 1/4" 209.55 mm	7" 177.80 mm	6 3/4" 171.45 mm
Dry Arcing Distance (in)/(mm)	5 1/2" 139.70 mm	4 1/2" 114.30 mm	4" 101.60 mm
Height (in)/(mm)	5 3/4" 146.05 mm	5 1/2" 139.70 mm	6 1/4" 158.75 mm
Diameter (in)/(mm)	7 1/2" 190.50 mm	6" 152.40 mm	4 3/8" 111.13 mm
Diameter of Clevis Ring (in)/(mm)	1 1/6" 26.99 mm	7/8" 22.23 mm	7/8" 22.23 mm
Mechanical Values			
ANSI M & E Category	15000 lbs.	10000 lbs.	10000 lbs.
Comb. M & E Strength	15000 lbs.	10000 lbs.	10000 lbs.
Mechanical Impact Strength	50 inch lbs.	45 inch lbs.	45 inch lbs.
Routine Proof Test	7500 lbs.	5000 lbs.	5000 lbs.
Time Load Test	10000 lbs.	6000 lbs.	6000 lbs.
Electrical Values			
Low Frequency Flashover Dry	65 kV	60 kV	60 kV
Low Frequency Flashover Wet	35 kV	30 kV	30 kV
Impulse Flashover Positive	115 kV	100 kV	100 kV
Impulse Flashover Negative	115 kV	100 kV	90 kV
Low Frequency Puncture Voltage	90 kV	80 kV	80 kV
Radio Influence Low Frequency Test Voltage Data			
Test Voltage, Rms to Ground, KV	7.5 kV	7.5 kV	7.5 kV
Maximum RIV at 1000 kHz - V	50	50	50
Weight			
Maximum Net Weight	9.1 lbs.	5.5 lbs.	5.2 lbs.
Packaged Weight Per Unit	10.1 lbs.	6.0 lbs.	5.8 lbs.
Packaging			
Standard Packaging Quantity	8	12	12
Insulator Coatings			
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Standard	Standard	Standard

Special Glaze Requirement Upon Request

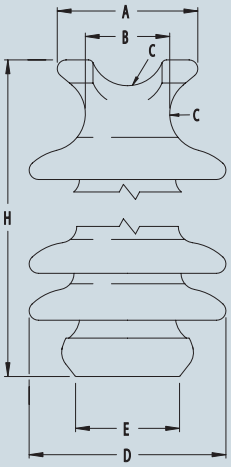
† Special Note: REA Accepted

T&D Insulators

Tie-Top Line Post Insulators



Type "F" Neck



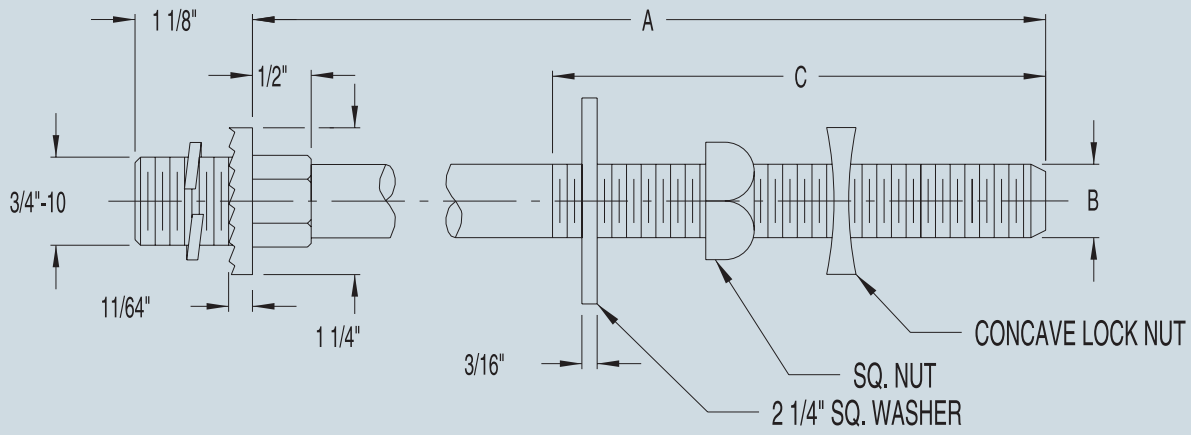
Type "C" Neck

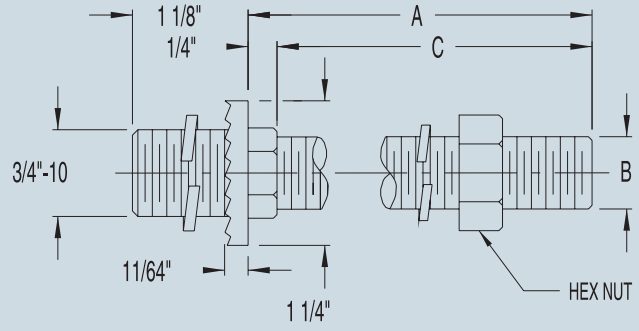
PPC Insulators Catalog Number	5015	5020	5025	5027	5035	5045	5115	5120	5125	5127	5135	5145
ANSI Technical Reference Number	N/A	N/A	57-1	N/A	57-2	57-3	N/A	N/A	57-1	N/A	57-2	57-3
Type "Neck"	C	C	C	C	C	C	F	F	F	F	F	F
Dimensions												
Dimension A - Inches	3 3/4"	3 3/4"	3 3/4"	3 3/4"	3 3/4"	3 3/4"	4 5/8"	4 5/8"	4 5/8"	4 5/8"	4 5/8"	4 5/8"
Dimension B - Inches	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 1/4"	2 7/8"	2 7/8"	2 7/8"	2 7/8"	2 7/8"	2 7/8"
Dimension C (radius) - Inches	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"	1"
Dimension D - Inches	4 3/4"	5 1/4"	5 1/2"	5 1/4"	6"	6 1/2"	4 3/4"	5 1/4"	5 1/2"	5 1/4"	6"	6 1/2"
Dimension E - Inches	3 5/9"	3 5/9"	3 5/9"	3 5/9"	4 5/9"	4 5/9"	3 5/9"	3 5/9"	3 5/9"	3 5/9"	4 5/9"	4 5/9"
Dimension H - Inches	7 3/4"	8 3/4"	8 4/5"	9 7/8"	12 1/16"	14 9/16"	7 3/4"	8 3/4"	8 4/5"	9 7/8"	12 1/16"	14 5/9"
Number of Skirts	3	4	4	5	6	8	3	4	4	5	6	8
Leakage Distance - Inches	7 1/2"	11"	14"	16"	22"	29"	7 1/2"	11"	14"	16"	22"	29"
Dry Arching Distance - Inches	5"	5 3/4"	6 1/2"	7 5/8"	9 1/2"	12 1/4"	5"	5 3/4"	6 1/2"	7 5/8"	9 1/2"	12 1/4"
Mechanical Values												
Cantilever Strength - lbs.	2000	2000	2800	1500	2800	2800	2000	2000	2800	1500	2800	2800
Cantilever Proof Load - lbs.	800	800	1120	800	1120	1120	800	800	1120	800	1120	1120
Electrical Values												
Typical Application kV	15	20	25	27	35	45	15	20	25	27	35	45
Low Frequency Flashover - Dry - kV	65	80	80	95	110	125	65	80	80	95	110	125
Low Frequency Flashover - Wet - kV	40	55	60	65	85	100	40	55	60	65	85	100
Critical Impulse Flashover (+) kV	100	110	130	140	180	210	100	110	130	140	180	210
Critical Impulse Flashover (-) kV	130	140	155	190	205	260	130	140	155	190	205	260
Radio Influence Voltage Data												
RIV RMS to Ground Test Voltage - kV	10	15	15	20	22	30	10	15	15	20	22	30
Maximum RIV at 1000 kHz - µV	50	50	100	50	100	200	50	50	100	50	100	200
Weight												
Net Weight per Unit - lbs.	7	8.5	9	8.5	18	25	7	8.5	9	8.5	18	25
Packaged Weight Per Unit - lbs.	72	52	55	52	74	102	72	52	55	52	74	102
Packaging												
Standard Package Quantity - Each	10	6	6	6	3	3	6	6	3	6	3	3
Insulator Coating												
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.	Std.

REA Accepted
All bases tapped for 3/4"-10 Stud Size
Typical application Voltage Values are listed as a guide for selection where operating conditions are normal.
Environmental factors may require the use of higher rated insulators or allow the use of lower rated insulators.

Studs For Line Post Insulators

Wood/Steel Crossarms





Long-For Wood Crossarms

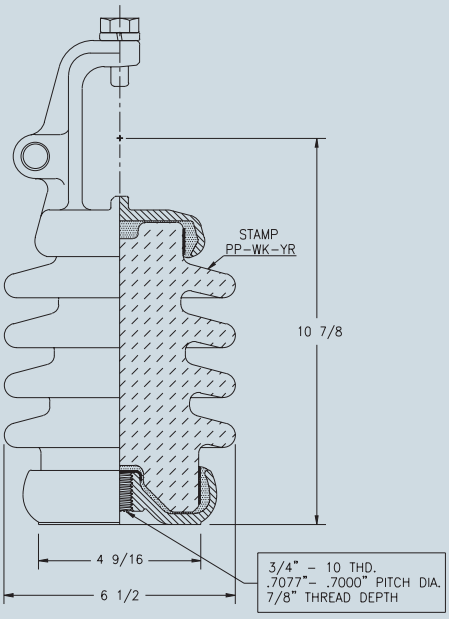
Catalog Number	6510	6512
Dimensions		
A	7 9/16"	7 9/16"
B	5/8" - 11	3/4" - 10
C	6"	6"

Short-For Steel Crossarms

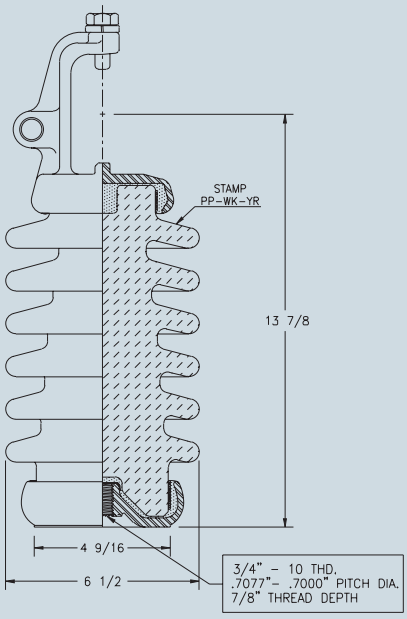
Catalog Number	6500	6502
Dimensions		
A	1 3/4"	1 3/4"
B	5/8" - 11	3/4" - 10
C	1 7/16"	1 7/16"

T&D Insulators

Horizontal Clamp Type Line Posts



No. 5225

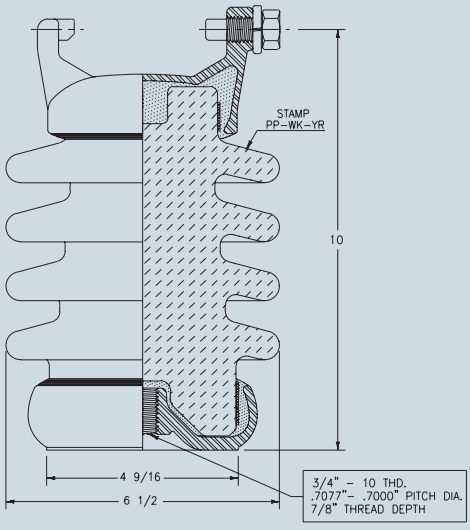


No. 5235

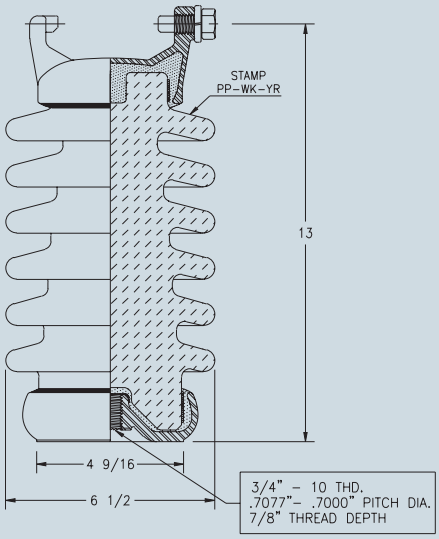
PPC Insulators Catalog Number	5225	5235
ANSI Technical Reference Number	57-21	57-22
Dimensions		
Leakage Distance (in)/(mm)	14" 355.60 mm	22" 558.80 mm
Dry Arcing Distance (in)/(mm)	6 1/2" 165.10 mm	9 1/2" 241.30 mm
Height To Middle of Clamp Assembly (in)/(mm)	10 7/8" 276.23 mm	13 7/8" 352.43 mm
Diameter (in)/(mm)	6 1/2" 165.10 mm	6 1/2" 165.10 mm
Mechanical Values		
Cantilever Strength	2800 lbs.	2800 lbs.
Cantilever Proof Load	1120 lbs.	1120 lbs.
Electrical Values		
Typical Line Voltage Application	25 kV	35 kV
Low Frequency Flashover Dry	80 kV	110 kV
Low Frequency Flashover Wet	70 kV	80 kV
Impulse Flashover Positive	130 kV	180 kV
Impulse Flashover Negative	155 kV	205 kV
Radio Influence Low Frequency Test Voltage Data		
Test Voltage, Rms to Ground, kV	15 kV	22 kV
Maximum RIV at 1000 kHz - µV	100	100
Weight		
Maximum Net Weight	15 lbs.	21 lbs.
Packaged Weight Per Unit	18 lbs.	25 lbs.
Packaging		
Standard Packaging Quantity	3	3
Insulator Coatings		
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Standard	Standard

Special Glaze Requirement Upon Request

Vertical Clamp Type Line Posts



No. 5325



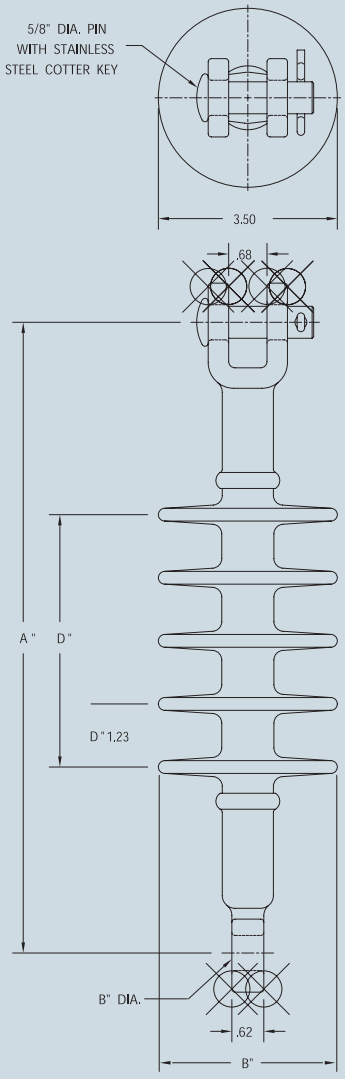
No. 5335

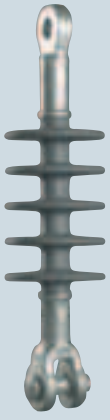
PPC Insulators Catalog Number	5325	5335
ANSI Technical Reference Number	57-11	57-12
Dimensions		
Leakage Distance (in)/(mm)	14" 355.60 mm	22" 558.80 mm
Dry Arcing Distance (in)/(mm)	6 1/2" 165.10 mm	9 1/2" 241.30 mm
Height To Middle of Single Cap Screw (in)/(mm)	10" 254.00 mm	13" 330.20 mm
Diameter (in)/(mm)	6 1/2" 165.10 mm	6 1/2" 165.10 mm
Mechanical Values		
Cantilever Strength	2800 lbs.	2800 lbs.
Cantilever Proof Load	1120 lbs.	1120 lbs.
Electrical Values		
Typical Line Voltage Application	25 kV	35 kV
Low Frequency Flashover Dry	80 kV	110 kV
Low Frequency Flashover Wet	60 kV	85 kV
Impulse Flashover Positive	130 kV	180 kV
Impulse Flashover Negative	155 kV	205 kV
Radio Influence Low Frequency Test Voltage Data		
Test Voltage, Rms to Ground, kV	15 kV	22 kV
Maximum RIV at 1000 kHz - µV	100	100
Weight		
Maximum Net Weight Per Unit	16 lbs.	25 lbs.
Packaged Weight Per Unit	19 lbs.	27 lbs.
Packaging		
Standard Packaging Quantity	3	3
Insulator Coatings		
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Standard	Standard

Special Glaze Requirement Upon Request

T&D Insulators

Polymer Deadend Insulators





Type PDEI 15

Type PDEI 25

Type PDEI 35

Material	End Fittings	Pin	Cotter Key
EPDM Rubber*	Malleable Iron, Hot dip galvanized	Steel, hot dip galvanized	Stainless steel

* For optional silicone rubber skirt material, add suffix " -S1" to the Catalog No. (Example: PDEI-15-SI)
1. Type PDEI, EPDM & Silicone Rubber Insulators meet or exceed the requirements of IEEE Standard 1024-1988
2. PDEI-15 and PDEI-25 insulators are REA listed in Bulletin 1728-C-100 "List of Materials Acceptable for Use on Systems of Electrical Borrowers" on page K(2)

Dimensional Data and Weights

Catalog Number	Dimensions				Number of Skirts	Weight	Standard Package Quantity
	A	B	C	D		Per lbs.	
PDEI-15	12 1/2"	3 1/2"	1 1/4"	4 15/16"	5	2 1/2	18
PDEI-25	17 3/4"	3 1/2"	1 1/4"	9 7/8"	9	3 5/16	18
PDEI-35	22 1/2"	3 1/2"	1 1/4"	14 13/16"	13	4 3/32	12

Specifications

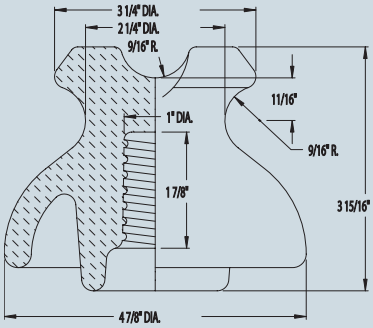
Catalog Number	kV Rating	IEEE Class 1	Tensile Strength Lbs.		Electrical Flashover - kV				Electric Leakage Distance
					60 Hertz		Impulse		
			Rating	Proof Test	Dry	Wet	Positive	Negative	(Inches)
PDEI-15	15	CI-1	15000	10000	90	65	140	170	16 1/2
PDEI-25	25	CI-2	15000	10000	130	110	215	225	26 5/8
PDEI-35	35	CI-4	15000	10000	145	130	250	270	42 13/16

T&D Insulators
Pintype Insulators

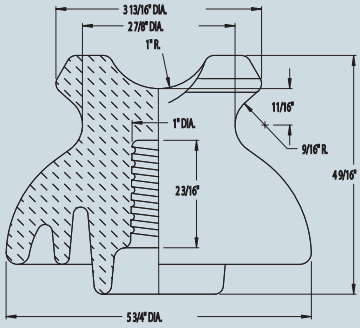
No. 261-S

No. 366-S

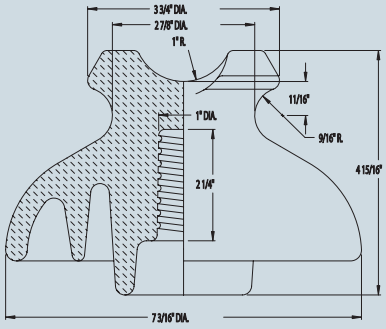
No. 380-S



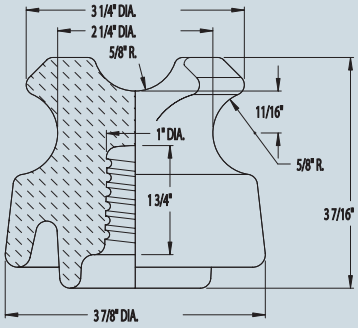
No. 261-S
ANSI Class 55-3
"C" Neck



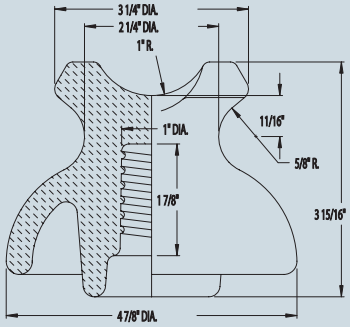
No. 366-S
ANSI Class 55-4
"F" Neck



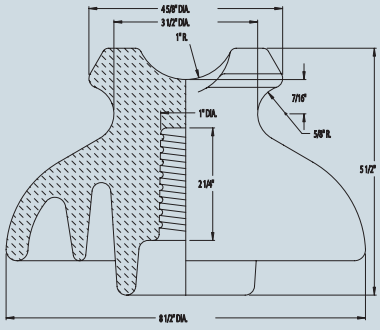
No. 380-S
ANSI Class 55-5
"F" Neck



No. 253-S
ANSI Class 55-2
"C" Neck



No. 263-S
"C" Neck



No. 386-ST
ANSI Class 55-6
"J" Neck

Mechanical & Electrical Characteristics

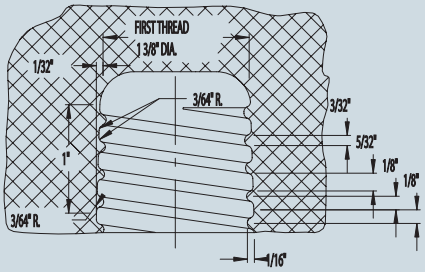
Catalog Number	†253-S	†261-S	263-S	†366-S	380-S	386-ST
Typical Application	7.2 kV	11.5 kV	11.5 kV	13.2 kV	14.4 kV	23 kV
Dry Flashover Voltage	45 kV	55 kV	55 kV	65 kV	80 kV	100 kV
Wet Flashover Voltage	25 kV	30 kV	30 kV	35 kV	45 kV	50 kV
Puncture Voltage	70 kV	90 kV	90 kV	95 kV	115 kV	135 kV
Impulse Flashover Positive	70 kV	90 kV	90 kV	105 kV	130 kV	150 kV
Impulse Flashover Negative	85 kV	110 kV	110 kV	130 kV	150 kV	170 kV
Leakage Distance	5"	7"	7"	9"	12"	15"
Dry Arcing Distance	3 3/8"	4 1/2"	4 1/2"	5"	6 1/4"	8"
Cantilever Strength	2500 lbs.	2500 lbs.	2500 lbs.	3000 lbs.	3000 lbs.	3000 lbs.
Minimum Pin Height	4"	5"	5"	5"	6"	7 1/2"
Net Weight Per 100	183 lbs.	225 lbs.	260 lbs.	390 lbs.	500 lbs.	890 lbs.
Package Weight Per 100	191 lbs.	254 lbs.	288 lbs.	400 lbs.	617 lbs.	938 lbs.
Standard Package Quantity	48	24	24	12	12	8

† REA Accepted
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4
Above Insulators furnished Standard with Semi-Conductive Glaze (Type S) to eliminate noise.
Plain Glaze available on Special Order.
Type-S Insulator Characteristics shown above.
See Page 20 for R.I.V. and impulse characteristics.
Typical application Voltage Values are listed as a guide for selection where operating conditions are normal. Environmental factors may require the use of higher rated insulators or allow the use of lower rated insulators.

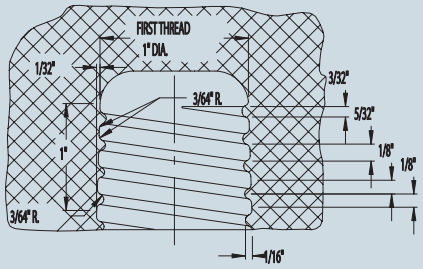
T&D Insulators

High Voltage Pintype Insulators

Standard Pinholes For PinType Insulators



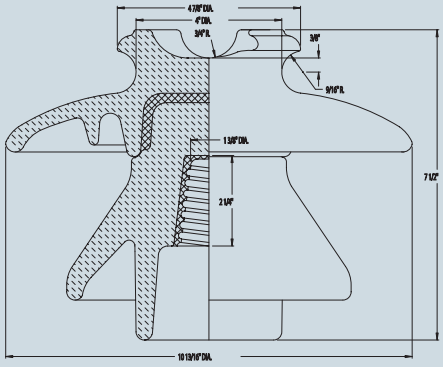
1" Pinhole



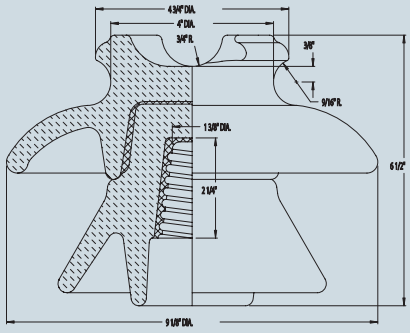
1 3/8" Pinhole

1027 ST

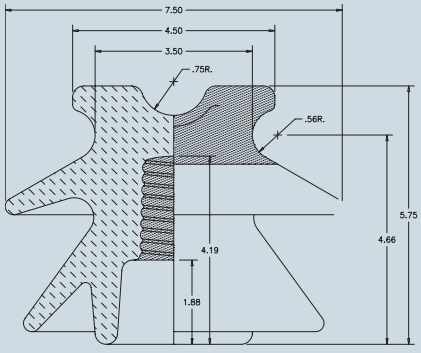
Threads – four threads per inch tapering 1/16" in diameter to 1" in length.
Each Pintype insulator thread fit is checked with thread gauge according to
ANSI C29.5 – 1969



No. 2045-S
ANSI Class 56-3
"K" Neck



No. 2033-S
ANSI Class 56-2
"K" Neck



No. 1027 ST
ANSI Class 56-1
"J" Neck

Mechanical & Electrical Characteristics

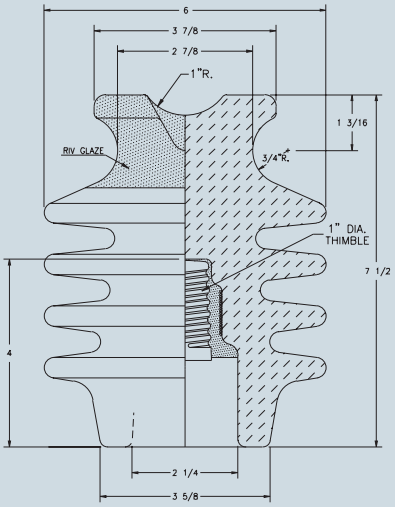
Catalog Number	†1027 ST	2033-S	†2045-S
Typical Application	23 kV	23 kV	34.5 kV
Dry Flashover Voltage	95 kV	110 kV	125 kV
Wet Flashover Voltage	60 kV	70 kV	80 kV
Puncture Voltage	130 kV	145 kV	165 kV
Impulse Flashover Positive	150 kV	175 kV	200 kV
Impulse Flashover Negative	190 kV	225 kV	265 kV
Leakage Distance	13"	17"	21"
Dry Arcing Distance	7"	8 1/4"	9 1/2"
Cantilever Strength	2500 lbs.	3000 lbs.	3000 lbs.
Minimum Pin Height	6"	7"	8"
Net Weight Per 100	752 lbs.	900 lbs.	1150 lbs.
Package Weight Per 100	800 lbs.	1025 lbs.	1375 lbs.
Standard Package Quantity	8	4	4

†REA Accepted
Standard Glaze "Skyline" ANSI-70,
Munsell 5 BG 7.0/0.4
Above Insulators furnished Standard with Semi-Conductive Glaze (Type S) to eliminate noise.
Plain Glaze available on Special Order. Type-S Insulator Characteristics shown above.
See below for R.I.V. and impulse characteristics.
Typical application Voltage Values are listed as a guide for selection where operating conditions are normal. Environmental factors may require the use of higher rated insulators or allow the use of lower rated insulators.

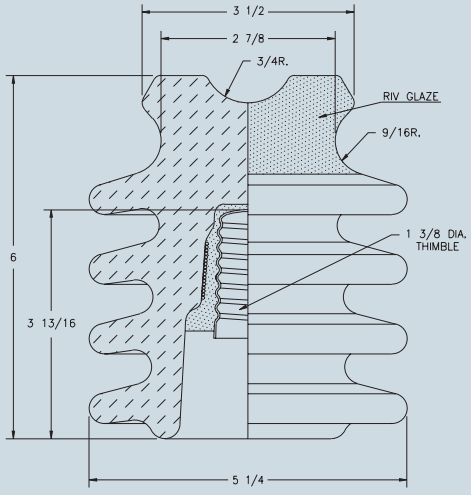
R. I. V. And Impulse Characteristics

Catalog Number		60 - Cycl Test Voltage	Maximum Radio Influence Voltage at 1000 KC - Microvolts		Type - S Impulse Flashover kV	
Plain	Type - S	kV	Plain	Type - S	Postitive	Negative
253	253 - S	15	2500	50	70	85
261	261 - S	10	5500	50	90	110
263	263 - S	10	5500	50	90	110
366	366 - S	10	5500	50	105	130
380	380 - S	15	8000	100	130	150
386	386 - S	22	8000	100	150	170
1027	1027 ST	15	8000	100	150	190
2033	2033 - S	22	12000	100	175	225
2045	2045 - S	30	16000	200	200	265

T&D Insulators
Pinpost Insulators



No. 400321



No. 410033

PPC Insulators Catalog Number	400321	410033
Dimensions		
Leakage Distance (in)/(mm)	18" 457.20 mm	13" 330.20 mm
Dry Arcing Distance (in)/(mm)	9" 228.60 mm	6 3/4" 171.45 mm
Height (in)/(mm)	7 1/2" 190.50 mm	6" 152.40 mm
Diameter (in)/(mm)	6" 152.40 mm	5 1/4" 133.35 mm
Mechanical Values		
Cantilever Strength	3000 lbs.	2500 lbs.
Electrical Values		
Typical Line Voltage Application	25 kV	27 kV
Low Frequency Flashover Dry	100 kV	85 kV
Low Frequency Flashover Wet	70 kV	60 kV
Impulse Flashover Positive	155 kV	140 kV
Impulse Flashover Negative	190 kV	170 kV
Low Voltage Puncture Voltage	160 kV	115 kV
Radio Influence Low Frequency Test Voltage Data		
Test Voltage, Rms to Ground, kV	20 kV	15 kV
Maximum RIV at 1000 kHz - µV	100	100
Weight		
Maximum Net Weight Per Unit	10 lbs.	5.85 lbs.
Packaged Weight Per Unit	10.50 lbs.	6.20 lbs.
Packaging		
Standard Packaging Quantity	6	6
Glaze		
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4	Standard with Semi-Conductive Glaze	Standard Semi-Conductive Glaze

Special Glaze Requirement Upon Request

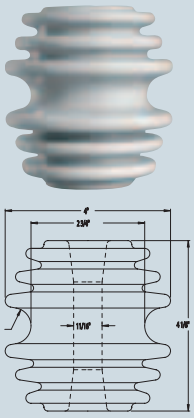
Beside insulators furnished standard with semi-conductive glaze to eliminate noise. Plain glaze available on special order.

Typical application Voltage Values are listed as a guide for selection where operating conditions are normal. Environmental factors may require the use of higher rated insulators or allow the use of lower rated insulators.

T&D Insulators

Spool and Guy Strain Insulators

Wet Process Porcelain



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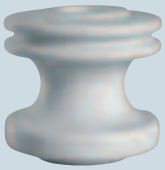
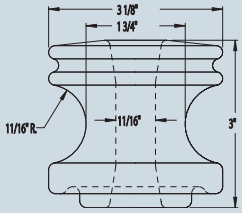

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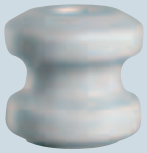
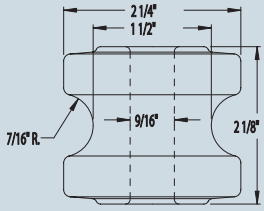

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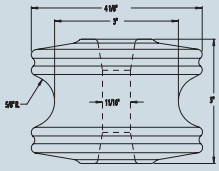

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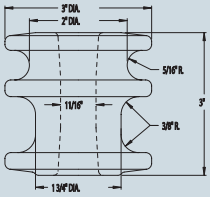

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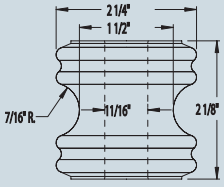

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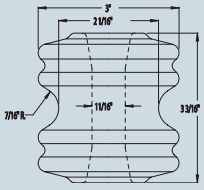
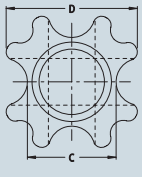


No. 5104

Mechanical And Electrical Characteristics

Catalog Number	ANSI	Ultimate Strength	Low Frequency Flashover - kV			Approximate Net Weight (lbs.)	Standard Package Quantity
			Dry	Wet			
	Class	lbs.		Vertical	Horizontal	Per 100 Pcs.	
†5101	53-2	3000	25	12	15	120	50
5102	N/A	3000	20	10	12	110	50
5104	53-3	4000	25	12	15	135	50
†5107	N/A	1750	18	7	9	45	100
5112	53-1	2000	20	8	10	50	100
5116	53-5	6000	35	18	25	260	25
†5119	53-4	4500	25	12	15	252	25

† REA Accepted
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4



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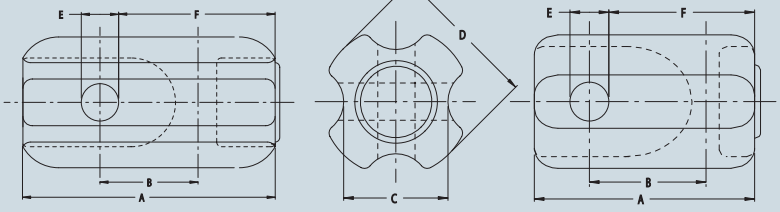
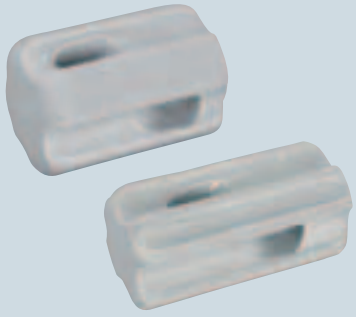


No. 502-504-506



Catalog Number	ANSI Class	Tensile Strength	Low Frequency Flashover kV		Leakage Distance	Maximum Cable Dia.	Dimensions (inches)						Approximate Net Weight (lbs.)	Standard Package Quantity
		lbs.	Dry	Wet	Inches	Inches	A	B	C	D	E	F	Per 100 Pcs.	
†502	54-1	10000	25	12	1 5/8"	3/8"	3 1/2"	1 3/4"	1 3/4"	2 1/2"	5/8"	2 5/16"	112	50
†504	54-2	12000	30	15	1 7/8"	1/2"	4 1/4"	2 1/4"	2 1/8"	2 7/8"	7/8"	2 13/16"	188	25
†506	54-3	20000	35	18	2 1/4"	5/8"	5 1/2"	3 1/8"	2 3/8"	3 3/8"	1"	3 13/16"	296	25
†508	54-4	20000	40	23	3"	5/8"	6 3/4"	2 5/8"	2 3/8"	3 1/2"	1"	4 1/2"	475	20

† REA Accepted
Standard Glaze "Skyline" ANSI-70, Munsell 5 BG 7.0/0.4

Cross Reference Guide

The comparative catalog numbers are intended as a guide only. It is recommended that each item be further identified by referring to that item in this catalog. All possible care has been exercised in preparing this Cross Reference Guide; however, we cannot assume responsibilities for discrepancies.

Suspension And Dead-End Insulators

ANSI Class Number	PPC Insulators	Ohio Brass	NGK (Locke)	Lapp	Joslyn (Pinco)	A.B. Chance	McGraw Edison	Victor
52-1	86012	32433	16583	6605 G	L 1510	C 907-1001		804
52-1	86046			6605 H	C 907-1211	804-40		
52-2	87512	32435			L 600			801
52-3	81022	32440	205840	8200	L 2060	C 907-1003		900
52-4	81012	32439	205580	8100	L 2070	C 907-1004		800
52-9	20034	47399		6815 G	74002	C 907-1209		877
52-9	20046					C 907-1210		877-40
52-9	84300	42399	16044	6815	L 1814	C 907-1009		817
	20122							
	20166					C 907-1704		
	84166					C 907-1604		

Tie-Top Line Post Insulators And Studs

ANSI Class Number	PPC Insulators	Ohio Brass	NGK (Locke)	Lapp	Joslyn (Pinco)	A.B. Chance	McGraw Edison	Victor
	5015	37600		4315 X		C 903-1710		
	5020	43400		4320 X		C 903-1711		
	5025							
	5027	43401		4327 X		C 903-1712		
	5035			4335 X				
	5045							
	5115			4315 -PX		C 903-1910		
	5120			4320 -PX		C 903-1911		2120
57-1	5125	37610		9325 X		C 903-1813		2025
	5127	47101		4327 -PX		C 903-1912		2127
57-2	5135	37620		9335 X		C 903-1814		62055
57-3	5145	41640		9345 X		C 903-1815		62056
	Studs							
	6500	87563		301613		C 903-9507		72090
	6502	87573		301614		C 903-9508		72088
	6510	87564		11612 A		C 903-9514		72091
	6512	87574		10187 A		C 903-9517		72087

PinType Insulators

ANSI Class Number	PPC Insulators	Ohio Brass	NGK (Locke)	Lapp	Joslyn (Pinco)	A.B. Chance	McGraw Edison	Victor
55-1	237	29207			L 62	C 905-1001		4
55-1	237 -S					C 905-1301		
55-2	253	12847			L 223	C 905-1002	NP 8D7	8
55-2	253 -S				L 223 R	C 905-1302	NP 8D8	8 R
55-3	261				L 63	C 905-1003	NP 9D7	5
55-3	261 -S	38148			L 63 R	C 905-1303	NP 9D8	5 R
55-4	366				L 2064	C 905-1004	NP 21D7	6
55-4	366 -S	38149			L 2064 R	C 905-1304	NP 21D8	6 R
55-5	380				L 367	C 905-1005	NP 22D7	9
55-5	380 -S	38151			L 367 R	C 905-1305	NP 22D8	9 R
55-6	386 -ST					C 905-1306	NP 23D8	11 R
56-1	1027 -S	38246			L 1123 R	C 906-1311		27 R
56-2	2033 -S	38222			L 72 R	C 906-1302		133 R
56-3	2045 -S	38223			L 75 R	C 906-1303		245 R

Guy Strain Insulators

ANSI Class Number	PPC Insulators	Ohio Brass	NGK (Locke)	Lapp	Joslyn (Pinco)	A.B. Chance	McGraw Edison	Victor
54-1	502	31502			L502	C 9090-1041		502
54-2	504	31504			L504	C 909-1042		504
54-3	506	31506			L506	C 909-1043		506
54-4	708	31352			L539	C 909-1044		556

Spool Insulators

ANSI Class Number	PPC Insulators	Ohio Brass	NGK (Locke)	Lapp	Joslyn (Pinco)	A.B. Chance	McGraw Edison	Victor
53-1	5112	36139			J 98	C 909-1031		2011
53-2	5101	36361			J 151	C 909-1032		2012
53-3	5104				J 97	C 909-1033		2013
53-4	5119	38911			J 0101	C 909-1034		2026
53-5	5116	36140			J 0613	C 909-1035		2014
	5107				J 150	C 909-1931		
	5102				J 105	C 909-1932		

www.ppcinsulators.com

CERAM INSULATORS

PP

The very Best.

That's what we deliver.

Only a company that develops, produces and delivers products worldwide can provide the optimal solution for your requirements.

The specialists of **PPC** Insulators are dedicated to supplying you with superior advice and global support. **PPC** Insulators quality products and service provide time-tested value to fulfill your needs!
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PPC INSULATORS

Revision 1/2003

SEVES

The very Best.

Ultra High Voltage

PPC INSULATORS

Ultra High Voltage.
The Specialist


photo: Siemens

Global Trend: Green Energy

Worldwide energy demand is projected to continue to increase rapidly in the next decades, particularly in Non-OECD countries. This is especially true in China, India, Latin America, Africa, as well as in the United States. Strong economic growth and increases in energy consumption, define the need for greater production and efficient distribution of electricity. Research has demonstrated a solution to increased transmission capacity with minimal environmental impact.

"Ultra High Voltage" (UHV)* is that solution. UHV is designed to deliver large quantities of power over long distances. Centers with growing demand, located far from the power generation resources, can enjoy significantly increased energy supply without a proliferation of transmission lines and with minimal loss of power.

This is not new. UHV networks have been installed in various parts of the world since the 1970s, involving both alternating current (AC) and direct current (DC) systems. While UHV AC systems generally provide short distance power transmissions at higher voltages, UHV DC systems are attractive for bulk power transmissions over long distances.

- More power
- Fewer lines
- Longer lines
- Reduced energy loss
- High voltage
- AC/DC

* in this paper defined as 765kV or higher in alternating current and 600 kV or higher in direct current

at Your Service.

PPC Solution: The very Best

With more than 100 years experience in designing and producing electro porcelain, it is not surprising that **PPC** Insulators has become the primary supplier to UHV equipment producers. Our extensive knowledge and production technology enables **PPC** Insulators to produce the best designs for both UHV hollow and solid core post insulators for up to 1200 kV AC and 800 kV DC system voltages.

PPC is able to produce numerous shed designs defined by IEC 60815 standards including alternating shed, plain shed, under rib shed and rain shed. Additionally we have unique shed designs for 800 kV DC applications. Further, optimized insulator designs have been developed by **PPC** with ultra high mechanical strengths and maximum extended creepage distances. These cannot be manufactured by conventional porcelain production technology – but are made possible by **PPC** Insulators ISOSTATIC TECHNOLOGY. This technology was invented by and successfully utilized by **PPC** Insulators for more than 40 years.

Hollow Insulators

- Power Transformer Bushings
- Instrument Transformer Bushings
- Circuit Breakers Bushings
- Surge Arrester Bushings
- Cable Termination Bushings

Post Insulators

- Disconnectors
- Bus Bars
- Earth Switches
- Line Traps
- Capacitor Bank Platforms

Significant effort is applied in continuous research and development by **PPC** Insulators to further improve the design and performance of our UHV porcelain insulators. The very best. That's what we deliver.

Hollow Insulators.

Advanced design. Large

PPC Development

PPC Insulators has been producing High Voltage and Ultra High Voltage bushings for system voltages above 245 kV since the 1950's. The epoxy jointing technology introduced in the 1970's enabled **PPC** Insulators to extend the height of the single porcelain design. Having produced epoxy jointed porcelain up to 765 kV in the 70's (8.450 mm height and 755 mm shed diameter), our continuous development and investment has enabled **PPC** to now manufacture insulators up to 1100kV for switchgear (DTB, LTB and GIS), instrument transformers (CT and CVT), power transformers and cable sealing ends.

Temperature Cycle Test

Bending Test

Decades of experience and continuous development in the high voltage insulators production as well as more than four decades of jointing knowledge shows proof of **PPC**'s ability to produce the best available UHV solutions. More than 60,000 jointed hollow insulators have been delivered to Original Equipment Manufacturers (OEM's) all over the world.

Tailored inside and outside – according to customer request!

dimensions. Close tolerances.

HEIGHT Single Porcelain	HEIGHT Jointed Porcelain	OUTSIDE DIAMETER	INSIDE DIAMETER
2900 mm	unlimited	800 mm	650 mm
114 inches		32 inches	26 inches

Dimensions

PPC hollow insulators are designed, engineered and manufactured to meet, and even surpass the exacting demands of OEM and industry customers in many applications and geographic areas.

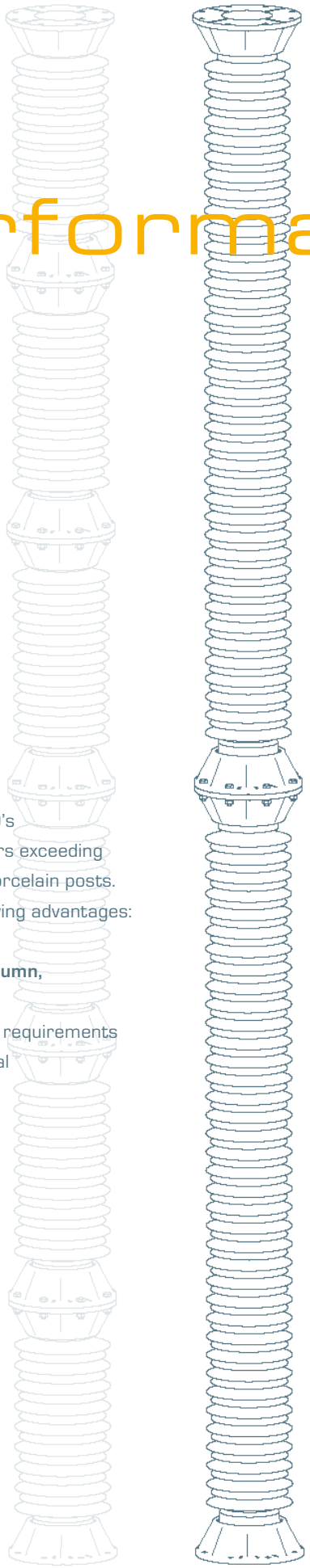
Dimensional values are general and may vary according to design. Many parameters must be considered, as ratio between height and core diameter, weight and wall thickness, and different inner diameters. Dimensions are continuously subject to improvements.

Continuous investment to enhance the production capabilities enables **PPC** Insulators to offer single porcelains up to 362 kV, where no limits in height are given for epoxy jointed hollow insulators.

References

For more than two decades Ultra High Voltage bushings, up to the highest system voltages, have been supplied to ABB, Alstom, Areva, New Northeast Electric (Shenyang) High Voltage Switchgear (NHVS), Passoni & Villa, Siemens and Xi'an Shiky XD amongst others.

Post Insulators.
Highest Performa



PPC Development

Extra High Voltage and Ultra High Voltage solid core post insulators have been produced by PPC Insulators since the 1980's. Continuous development and investment allows us to manufacture insulators up to 1200kV AC and 800kV DC for bus bars support, disconnectors, earth switches, smoothing reactors, line traps, platform banks and any other type of post insulator application in this voltage range.

The isostatic technology introduced in the 1970's enables **PPC** Insulators to deliver insulators exceeding the size of conventional manufactured porcelain posts. Our advanced post designs include following advantages:

Fewer single sections per insulator column, therefore fewer metal parts allows for shorter column heights while maintaining requirements given in IEC 60815 and fulfilling all additional electrical requirements

improved flashover distance

improved pollution performance
by improved Form Factor acc. to IEC 60815

reduced weight, better utilization of material
simplifies handling

less use of metal
(fewer points of exposure to corrosion)

less field concentrating positions

improved mechanical stability, stiffness

nce.

HEIGHT Single Porcelain	HEIGHT Total Stack	SHED DIAMETER
2850 mm	unlimited	530 mm
112 inches		21 inches

Dimensions

Continuous investment to enhance the production capabilities enables **PPC** Insulators to manufacture 765 kV porcelain columns for BIL 2100 kV to BIL 2550 kV in two section designs.

For outdoor UHV DC applications, insulators have extremely high creepage distance requirements dictating the need for increased support post insulator heights. These increased heights require an increased bending moment at the bottom of the insulator, resulting in larger porcelain core diameters. This in many cases has not been possible to produce in the past.

PPC's Insulite designs using our isostatic manufacturing process allow for higher specific creepage distances and cantilever strengths for UHV DC applications. These new technologies make it possible for **PPC** to design and manufacture UHV DC large post insulators columns with – as an example – the following main parameters:

main parameters	
System voltage	800 kV DC
Lightning Impulse Withstand Voltage	
dry	> 2550 kV
wet	> 1550 kV
Specific creepage distance	> 60 mm/kV
Total creepage distance	> 49200 mm
Cantilever strength	12.5 kN
Bending moment at bottom	150 kNm
Configuration	tapered
Total height	12 m

References

For many years, post Insulators ≥ 765 kV AC and ≥ 600 kV DC have been delivered to customers like ABB, Areva, Actom, Coelme, Hapam, New Northeast Electric (Shenyang) High Voltage Switchgear and Siemens.

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