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PPC INSULATORS

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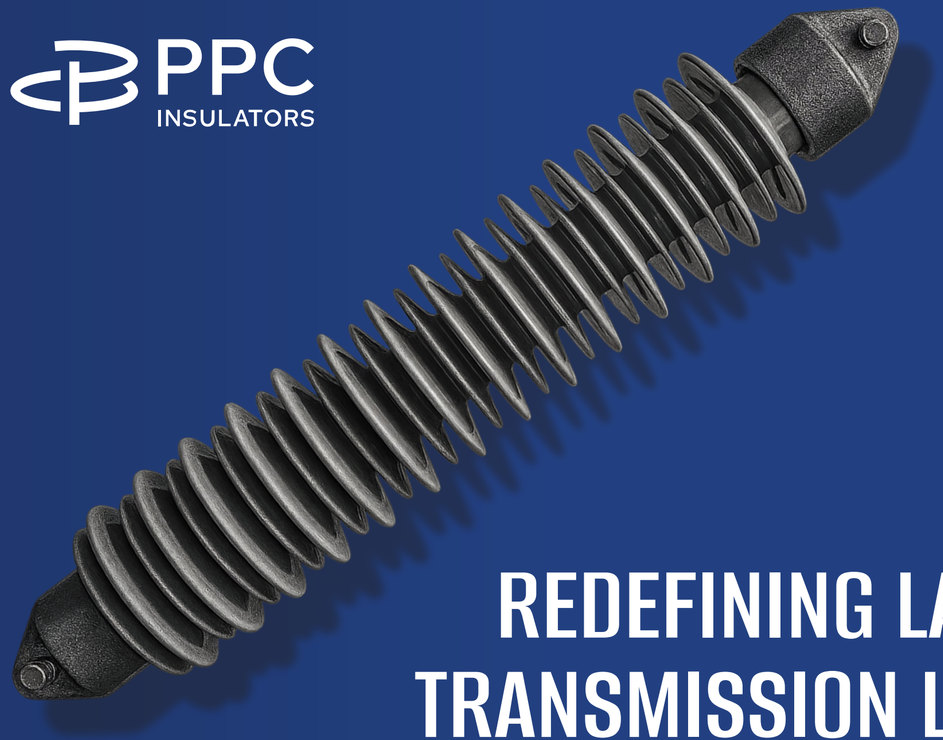

LONG RODS

REDEFINING LATAM TRANSMISSION LINES

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INTRODUCTION

PPC Santana has been at the forefront of porcelain insulator development for over 80 years, supporting the resilience and advancement of the global electrical grid through the continuous development and innovation of ceramic insulator solutions.

For many years, transmission lines in LATAM have relied on glass and ceramic Cap & Pin insulators. However, as grid challenges continue to evolve, so do the insulation needs of transmission line operators striving to deliver safe, sustainable power.

With a 50+ year history of manufacturing and supplying Long Rods to utilities across Europe, the Middle East, and beyond, our engineers realised the potential benefits that the technology could offer the LATAM grid in response to these challenges.

MODERN GRID CHALLENGES

AGING INFRASTRUCTURE

Increasing electrical demand and the move to renewable energy pose a significant challenge for the aging grid infrastructure in LATAM. Superior grid technology is needed to support the clean energy transition.

GROWING POWER DEMAND

As utilities increase capacity to meet growing demand, they face right-of-way challenges and high construction costs. They need a more labor-efficient and cost-effective way of expanding transmission line capacity.

INCREASING ENVIRONMENTAL EXTREMES

As climate activity becomes more unpredictable, transmission line operators want to ensure that their insulators are built to withstand environmental volatility.

PRESSURE TO REDUCE CARBON FOOTPRINT

With many utilities working toward decarbonization targets, they are looking for a more environmentally friendly way to increase capacity.

WHAT ARE LONG RODS?

First manufactured in the 1950s, Porcelain Long Rods are resilient, adaptable single-unit insulators used in distribution and transmission lines.

MATERIAL COMPOSITION - ADVANCED MECHANICAL STRENGTH

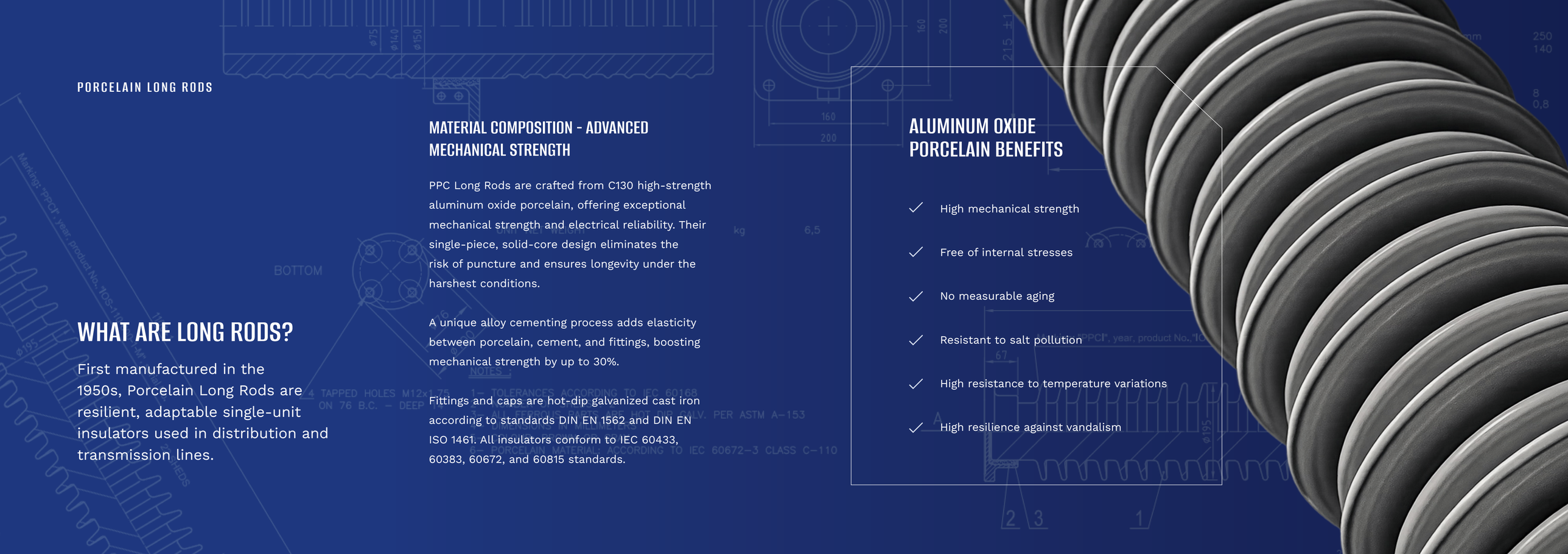
PPC Long Rods are crafted from C130 high-strength aluminum oxide porcelain, offering exceptional mechanical strength and electrical reliability. Their single-piece, solid-core design eliminates the risk of puncture and ensures longevity under the harshest conditions.

A unique alloy cementing process adds elasticity between porcelain, cement, and fittings, boosting mechanical strength by up to 30%.

Fittings and caps are hot-dip galvanized cast iron according to standards DIN EN 1562 and DIN EN ISO 1461. All insulators conform to IEC 60433, 60383, 60672, and 60815 standards.

ALUMINUM OXIDE PORCELAIN BENEFITS

- ✓ High mechanical strength
- ✓ Free of internal stresses
- ✓ No measurable aging
- ✓ Resistant to salt pollution
- ✓ High resistance to temperature variations
- ✓ High resilience against vandalism



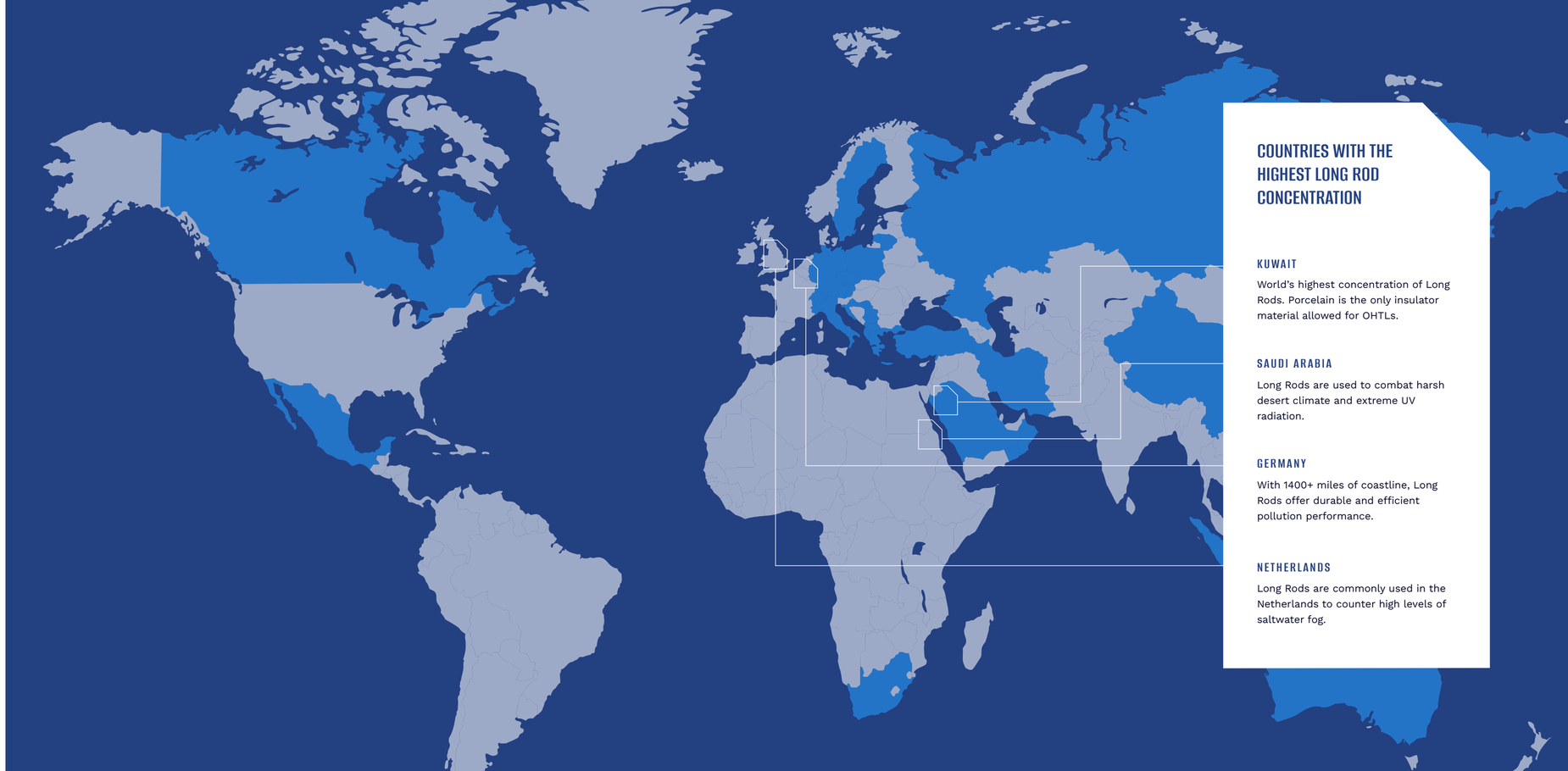
A SUPERIOR ALTERNATIVE TO C&P INSULATORS

Porcelain Long Rod insulators offer increased resilience, durability and performance under modern line challenges such as extreme pollution, vandalism, and the pressure to expand generation capacity while maintaining cost and carbon efficiency. Their robust design ensures long-term reliability in harsh environments, supporting stable grid operations and reducing maintenance requirements.

A TRIED AND TRUE GLOBAL STANDARD

Porcelain Long Rods have protected transmission lines across Europe, the Middle East, and Asia since the 1950s, having become a global standard due to their superior dielectric properties, durability, and performance in challenging environmental conditions.

PPC Long Rod Insulators help to maintain grid resilience in more than 70 countries worldwide. With a proven service life exceeding 50 years and no recorded in-field structural failures in the last 5 decades, our Long Rods are a cornerstone of modern transmission infrastructure.



COUNTRIES WITH THE HIGHEST LONG ROD CONCENTRATION

KUWAIT

World's highest concentration of Long Rods. Porcelain is the only insulator material allowed for OHTLs.

SAUDI ARABIA

Long Rods are used to combat harsh desert climate and extreme UV radiation.

GERMANY

With 1400+ miles of coastline, Long Rods offer durable and efficient pollution performance.

NETHERLANDS

Long Rods are commonly used in the Netherlands to counter high levels of saltwater fog.

LONG RODS DESIGN ADVANTAGES

MINIMAL USE OF METAL PARTS REDUCES WEIGHT AND CORROSION RISK

PUNCTURE-PROOF ACCORDING TO IEC 60383

LOW SURFACE LEAKAGE CURRENT REDUCES TRANSMISSION LOSSES

PROTECTIVE FITTINGS ELIMINATE CASCADE FLASHOVERS

SHED UNDERRIBS NOT REQUIRED, MINIMIZING THE ACCUMULATION OF CONTAMINATION

EXTENDED CREEPAGE DISTANCE DUE TO SINGLE-UNIT DESIGN

KEY PERFORMANCE FEATURES

LAPP Porcelain Long Rods feature several key advantages, making them a superior insulation choice.

EXTENDED CREEPAGE DISTANCE

Due to their single-unit design, Porcelain Long Rods offer up to 30% more creepage distance compared to standard Cap & Pin insulators, significantly enhancing insulation effectiveness.

OPTIMIZED FLASHOVER DISTANCE

PPC Long rods are designed to ensure that any flashover occurs externally, safeguarding the integrity of the insulator.

PUNCTURE-PROOF DESIGN

Porcelain Long Rods are designated as puncture-proof under IEC Standard 60383.

SELF-CLEANING

Designed without under-ribs to minimize the accumulation of pollutants, Porcelain Long Rods are 100% self-cleaning, improving contamination performance and reducing maintenance and washing requirements.

LIGHTWEIGHT & DURABLE

As Long Rod insulators are single units, metal components are reduced, meaning they are lighter. This also reduces concerns around metal corrosion.

COMPARING LONG RODS TO C&P INSULATORS

PPC PORCELAIN LONG RODS	VS	CAP & PIN
Puncture-proof (IEC 60383)		Vulnerable to puncture Steep wave testing required
No need to stock replacements		Replacement stock always necessary
40% lighter due to minimal metal parts – 3 per insulator		15-30 metal components per string – heavy and prone to corrosion
No encapsulated cement to cause hoop stress failure		Portland concrete used in assembly – at risk of material expansion
Inspection every 2-3 years - 50-60% less maintenance		Yearly inspection required
Suitable for compact line design		Unsuitable for compact line design

LONG RODS KEY BENEFITS

POLLUTION PERFORMANCE

POLLUTION-RESISTANT BY DESIGN

PPC Porcelain Long Rod Insulators are designed with pollution resistance as a central performance feature.

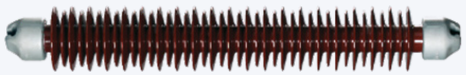
A standout aspect of their resilience is the absence of under-ribs found in other insulator types, which tend to trap pollutants.

By eliminating these under-ribs, PPC Long Rods allow for a smoother surface profile that minimizes pollutant accumulation. In addition to this, the shed design of Long Rods means they are 100% self-cleaning, so any debris is cleared naturally by wind or rain.

ENGINEERED TO PERFORM IN ANY ENVIRONMENT

Shed profile customization allows our Long Rods to be adapted to counteract any environmental conditions, reducing the likelihood of flashover. For example, Desert Shed design is used to combat contamination buildup during extended dry seasons in arid climates, while a Steep Shed design can be used to reduce contamination accumulation in coastal regions prone to saltwater fog.

C&P insulators with pollution accumulation on underribs



Porcelain Long Rod shed design without underribs

CASE STUDY

PROVEN INSULATOR PERFORMANCE IN SALT-LADEN COASTAL CONDITIONS

THE CHALLENGE

In coastal regions of the Netherlands, high salt content in the air presents a persistent threat to transmission line insulators.

Similar to conditions along the Brazilian coast, the Dutch shoreline often experiences dense fog and mist saturated with saline particles from the North Sea.

When this salt settles on insulator surfaces, it can create conductive paths that heighten the risk of electrical discharge or flashover events.

THE SOLUTION - OPTIMIZED STEEP SHED GEOMETRY

To address this issue, Dutch transmission operators have implemented high-performance insulators specifically designed for severe environmental exposure. PPC Porcelain Long Rod insulators, engineered with an advanced steep shed profile, offer advanced pollution performance against heavy salt contamination.

The steeply angled sheds promote rapid drainage of moisture, minimizing surface wetting and reducing the potential for the formation of a conductive slurry.

The enhanced creepage distance offered by the shed geometry provides an added layer of defense, supporting consistent dielectric performance even in heavily polluted settings.

Porcelain, as a base material, delivers long-lasting durability and resistance to UV exposure, thermal stress, and marine corrosion. Unlike some composite alternatives, porcelain retains its mechanical integrity and insulation quality over decades, making it ideal for demanding coastal installations.

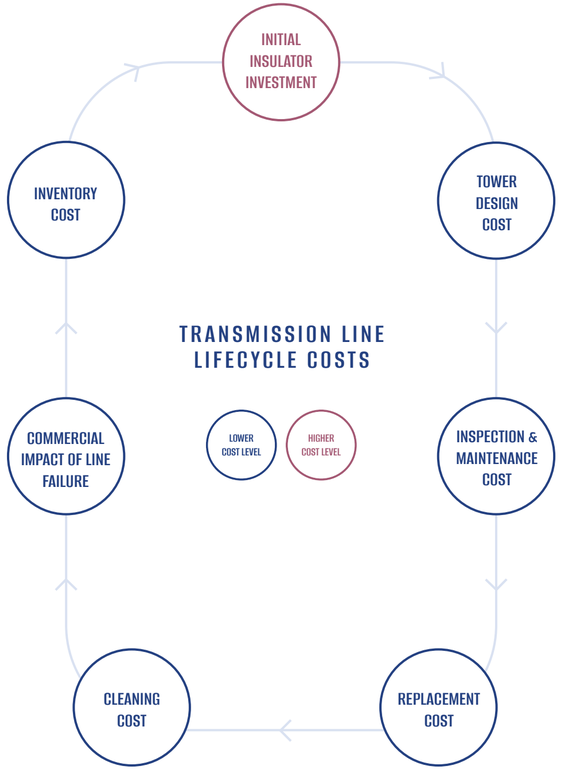
THE OUTCOME

By deploying PPC Porcelain Long Rods with steep shed configurations, Dutch utilities ensure stable grid performance in foggy, salt-rich coastal environments. This reliable solution contributes to the ongoing safety and efficiency of transmission infrastructure.

TOTAL COST OF OWNERSHIP

LONG LIFESPAN, LESS MAINTENANCE, LOWEST COST OF OWNERSHIP

The reduced maintenance requirements and extensive lifespan of Porcelain Long Rods mean that they have the lowest Total Cost of Ownership (TCO) of all transmission line insulator types.



REDUCED MAINTENANCE COSTS

The shatterproof and puncture-proof attributes of Porcelain Long Rods, along with the minimal metal components, mean that they require less maintenance and inspection than other transmission line insulator types.

REDUCED CLEANING COSTS

The self-cleaning nature of Porcelain Long Rods eliminates the need for washing.

REDUCED REPLACEMENT & INVENTORY COSTS

There have been no reported failures of PPC Santana Long Rod insulators over the past 5 decades, meaning inventory stock is not needed as insulators only need to be replaced as part of scheduled maintenance.

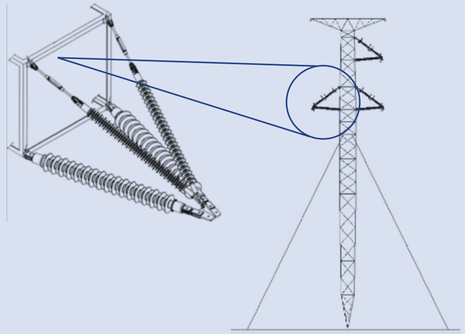
REDUCING THE COST OF TOWER DESIGN WITH COMPACT LINES

Compact lines are an ideal solution to the expense of right-of-way issues and spiralling material costs currently faced by utilities as they attempt to expand their network to meet rising power demand.

CONVENTIONAL LINE DESIGN CHALLENGES

As utilities work to meet increasing power demand, they encounter a number of obstacles.

- High land costs
- Right-of-way (RoW) issues
- High materials, construction and labor costs
- Pressure to reduce carbon footprint and reduce the amount of trees cut



ENABLING TRANSMISSION LINE COMPACTION WITH LONG RODS

The rigid single-unit composition of Long Rods makes them a suitable insulator for the compaction of transmission lines.

- The ability to uprate voltage in existing corridors
- Reduced land usage, RoW, and ongoing land maintenance costs
- Decreased construction material costs due to smaller towers
- Decreased foundation depth, meaning less labor and materials required
- Reduced tree felling

CASE STUDY

QUANTIFYING COST AND CARBON SAVINGS ENABLED BY LINE COMPACTION

THE STUDY

In 2023, a study was undertaken by PPC Santana in collaboration with Versatil Engenharia and Connect Sistemas on an 168km stretch of transmission line in Brazil.

The project aimed to investigate the potential cost and carbon benefits of replacing traditional steel towers with insulated cross-arm compact towers.

THE SOLUTION

By using an Insulated Cross Arm compact tower design, it was found that the same line performance could be achieved with a tower that was 2.3m smaller than the original structure. The compact tower also occupied less space, requiring 3m less clearance on either side than the conventional tower.

THE OUTCOME

The compaction of the tower resulted in the following savings:

- 15% Right of Way reduction, meaning a 15% reduction in land costs and less ongoing land maintenance
- 10.2% decrease in tower construction costs, and the related carbon output
- 3,300 fewer trees felled per km of transmission line

THE LOWEST CARBON FOOTPRINT OF ALL INSULATORS

Made from natural ingredients and fully recyclable, PPC Santana Long Rods are the most carbon-friendly transmission line insulators on the planet.

LOWER CARBON TO MANUFACTURE

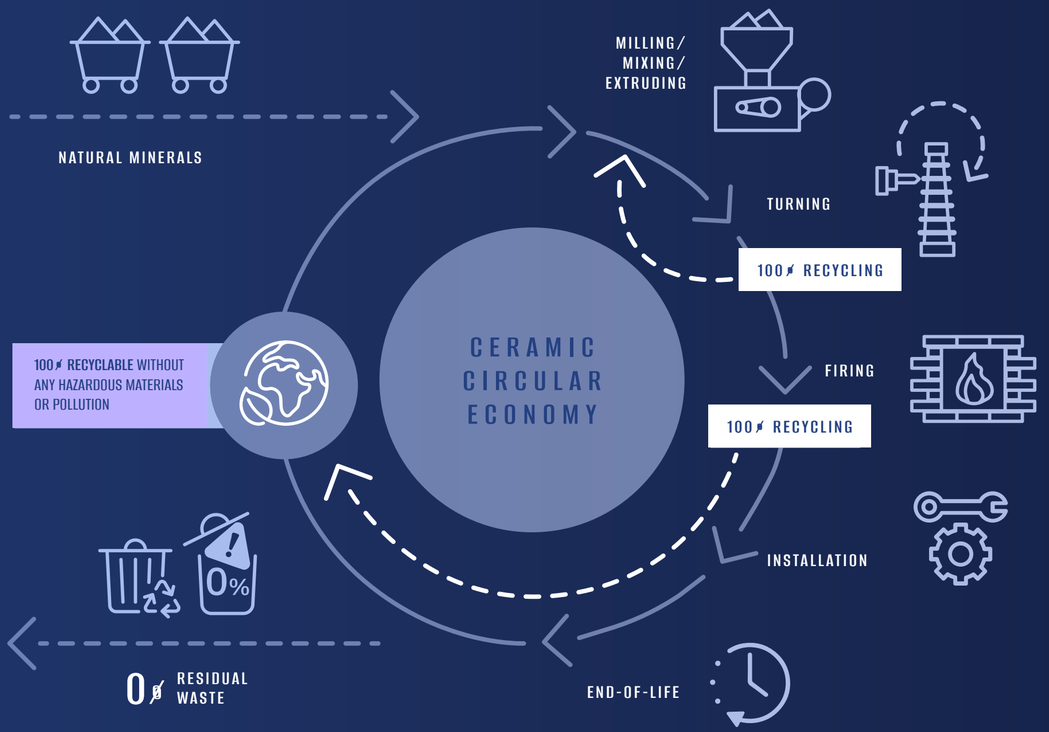
Natural non-refined ingredients such as feldspar, kaolin, silicate and alumina mean a low baseline carbon footprint.

LOWER CARBON IN SERVICE

Due to an extremely long lifespan and lower maintenance requirements.

LOWER CARBON AT END-OF-LIFE

Porcelain Long Rod insulators are 100% recyclable.



LONG ROD INSULATORS WITH BALL & 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

IEC 60433	DIN 48006/1	Core diameter d2 (mm)	Highest system voltage Um (kV)	Standard lightning impulse withstand voltage (kV)	Wet power frequency withstand voltage (kV)	Specified mechanical failing load (kN)	Routine mechanical test load (kN)	Minimum nominal creepage distance (16 mm/kV) (mm)	Maximum nominal length L (mm)	Standard coupling size (pin diameter) d1 (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	11
L 100 B 170	-	60	36	170	70	100	80	576	450	16
L 100 B 250	-	60	52	250	95	100	80	832	580	16
L 100 B 325	LP 60/19/870	60	72.5	325	140	100	80	1160	870	16
L 100 B 450	-	60	123	450	185	100	80	1968	1085	16
L 100 B 550	LP 60/30/1240	60	123	550	230	100	80	1968	1240	16
L 120 B 325	LP 60/19/870	60	72.5	325	140	120	96	1160	870	16
L 120 B 450	-	60	123	450	185	120	96	1968	1085	16
L 120 B 550	LP 60/30/1240	60	123	550	230	120	96	1968	1240	16
L 120 B 650	-	60	145	650	275	120	96	2320	1430	16
L 160 B 325	LP 75/14/870	75	72.5	325	140	160	128	1160	885	20
L 160 B 450	-	75	123	450	185	160	128	1968	1100	20
L 160 B 550	LP 75/22/1250	75	123	550	230	160	128	1968	1255	20
L 160 B 650	-	75	145	650	275	160	128	2320	1445	20
L 210 B 325	LP 85/14/900	85	72.5	325	140	210	168	1160	905	20
L 210 B 450	-	85	123	450	185	210	168	1968	1120	20
L 210 B 550	LP 85/22/1270	85	123	550	230	210	168	1968	1275	20
L 210 B 650	-	85	145	650	275	210	168	2320	1465	20
L 250 B 550	LP 95/22/1330	95	123	550	230	250	200	1968	1305	24
L 250 B 650	-	95	145	650	275	250	200	2320	1500	24
L 300 B 550	LP 105/22/1330	105	123	550	230	300	240	1968	1330	24
L 300 B 650	-	105	145	650	275	300	240	2320	1520	24

SPECIFICATION & TESTING

LONG ROD INSULATORS WITH CLEVIS & 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

IEC 60433	DIN 48006/2	Core diameter d2 (mm)	Highest system voltage Um (kV)	Standard lightning impulse withstand voltage (kV)	Wet power frequency withstand voltage (kV)	Specified mechanical failing load (kN)	Routine mechanical test load (kN)	Minimum nominal creepage distance (16 mm/kV) (mm)	Maximum nominal length L (mm)	Standard coupling size (pin diameter) d1 (mm)
L 100 C 170	-	60	36	170	70	100	80	576	475	-
L 100 C 250	-	60	52	250	95	100	80	832	605	-
L 100 C 325	LG 60/14/860	60	72.5	325	140	100	80	1160	900	19
L 100 C 450	-	60	123	450	185	100	80	1968	1120	19
L 100 C 550	LG 60/30/1270	60	123	550	230	100	80	1968	1270	19
L 120 C 325	LG 60/19/900	60	72.5	325	140	120	96	1160	905	19
L 120 C 450	-	60	123	450	185	120	96	1968	1120	19
L 120 C 550	LG 60/30/1270	60	123	550	230	120	96	1968	1275	19
L 120 C 650	-	60	145	650	275	120	96	2320	1465	19
L 160 C 325	LG 75/14/900	75	72.5	325	140	160	128	1160	920	19
L 160 C 450	-	75	123	450	185	160	128	1968	1135	19
L 160 C 550	LG 75/22/1270	75	123	550	230	160	128	1968	1290	19
L 160 C 650	-	75	145	650	275	160	128	2320	1465	19
L 210 C 325	LG 85/14/940	85	72.5	325	140	210	168	1160	940	22
L 210 C 450	-	85	123	450	185	210	168	1968	1155	22
L 210 C 550	LG 85/22/1310	85	123	550	230	210	168	1968	1310	22
L 210 C 650	-	85	145	650	275	210	168	2320	1500	22
L 250 C 550	LG 95/22/1340	95	123	550	230	250	200	1968	1335	22
L 250 C 650	-	95	145	650	275	250	200	2320	1530	25
L 300 C 550	LG 105/22/1370	105	123	550	230	300	240	1968	1365	25
L 300 C 650	-	105	145	650	275	300	240	2320	1560	25

INSPECTION & TESTING

	TYPE	SAMPLE	ROUTINE
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			×

ABOUT PPC SANTANA

STRENGTHENING THE RELIABILITY AND RESILIENCE OF THE ELECTRICAL GRID.

At PPC Santana, our mission is clear: to strengthen the reliability and resilience of the electrical grid. We accomplish this by engineering and producing some of the world's most durable and high-performing insulators, designed to deliver superior electrical and mechanical strength while maintaining one of the lowest carbon footprints in the industry.

With more than 80 years of innovation and technical excellence, PPC Santana has earned its place as a leader in porcelain insulator performance in LATAM, supported on a wider scale by the global PPC brand.

As a trusted partner to utilities and energy providers worldwide, we combine proven expertise with a collaborative mindset to help power networks meet increasing demands with confidence and stability.
We are not just manufacturers, we are partners. We listen closely, advise intelligently, and work alongside our customers to develop tailored solutions for the most demanding environments.

Whether it's product development or on-the-ground technical support, our team delivers with precision, consistency, and a commitment to long-term success.

PPC Santana is here to move the industry forward, deliberately, dependably, and sustainably.
LAPP exists to lead the industry forward - purposefully, reliably, and sustainably.

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