Technical Specification code: MAT-E&C-NC-2021-0043-EGIN
Version no. 3 dated 26/07/2021

Subject: Global Infrastructure and Networks – GSCC010 Composite Insulators for Medium Voltage Lines

Application Areas
Perimeter: *Global*
Staff Function: -
Service Function: -
Business Line: *Infrastructure & Networks*

CONTENTS

THE HEAD OF NETWORK COMPONENTS
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1 DOCUMENT AIMS AND APPLICATION AREA

The scope of this document is to provide the technical requirements for the supply of MV composite insulators to be used in the MV lines of the distribution networks of Enel Group Distribution Companies, listed below:

Country	Distribution Company
Argentina	Edesur
Brazil	Enel Distribuição Rio Enel Distribuição Ceará Enel Distribuição Goiás Enel Enel Distribuição São Paulo
Chile	Enel Distribución Chile
Colombia	Enel Codensa
Iberia	e-distribución
Italy	e-distribuzione
Peru	Enel Distribución Perú
Romania	Enel Distributie Banat Enel Distributie Dobrogea Enel Distributie Muntenia

Table 1 - Distribution Companies

This document specifies the characteristics and tests that shall be accomplished by the composite insulators used in the medium voltage distribution network.

1.1 RELATED DOCUMENTS TO BE IMPLEMENTED AT COUNTRY LEVEL

This document applies to both Enel Global Infrastructure and Networks Srl Company and to Infrastructure and Networks Business Line perimeter when each Company does not have to issue further documents.

2 DOCUMENT VERSION MANAGEMENT

Revision	Data	List of modifications
00	17/11/2017	First emission.
01	21/02/2018	Editorial corrections. Missed codes.
02	23/04/2019	New codes Brazil and Colombia. EDSP convergence. Recodification Chile and Perú. Tracking Perú. Creepage distance reference. Check lists.
03	05/07/2021	Issuing of "Global Infrastructure and Networks – GSCC010 COMPOSITE INSULATORS FOR MEDIUM VOLTAGE LINES" technical specification. New convergence to reduce the global types (mechanical and electrical properties, dimensions). Bolt unification. Improvement of silicon quality with new fingerprint tests. Introduction of line post insulators for covered conductor. More detailed specification.

Table 2 Document version

3 UNITS IN CHARGE OF THE DOCUMENT

Responsible for drawing up the document:

- Global Infrastructure and Networks: Engineering and Construction / Components and Devices Design/ Network Components

Responsible for authorizing the document:

- Global Infrastructure and Networks: Head of Engineering and Construction unit
- Global Infrastructure and Networks: Head of Health, Safety, Environment and Quality unit.

4 REFERENCES

- Code of Ethics of Enel Group.
- Enel Human Right Policy.
- The Enel Group Zero Tolerance of Corruption (ZTC) Plan.
- Organization and management model as per Legislative Decree No. 231/2001.
- RACI Handbook Infrastructure and Networks no. 06.
- Enel Global Compliance Program (EGCP).
- Integrated Policy of Quality, Health and Safety, Environment and anti-Bribery.

5 ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY

Value Chain/Process Area: Networks Management

Macro Process: Materials management

Process: Network Components Standardization

6 DEFINITIONS AND ACRONYMS

The vocabulary used in this global standard is based upon the vocabulary stablished in IEC 62217, IEC 61109 and IEC 61952.

7 DESCRIPTION

7.1 LIST OF COMPONENTS

Use	GS code	Country	Country code	Designation	Material maximum voltage (U_m) [kV]	Wet Power frequency withstand voltage [kV]	Dry Lighting impulse withstand voltage [kV]	Minimum creepage distance [mm]	Minimum arcing distance [mm]	Pollution level	Total length [mm]	Specific Mechanical Load (SML) [kN]	End fitting pole side	End fitting conductor side	Core material	Housing material	Fitting material
For new and existing lines	GSCC010/01	Argentina	0106-0278	CS 70 CT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/01	Brazil	990293	CS 70 CT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/01	Colombia	300013	CS 70 CT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/01	Chile	300016	CS 70 CT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/01	Italy	300002	CS 70 TT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Tongue 13 L Acc IEC 60471	Tongue 13 L Acc IEC 60471	ERGFR	HTV	HDGFS
	GSCC010/01	Peru	300019	CS 70 CT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/01	Romania	300002	CS 70 TT 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Tongue 13 L Acc IEC 60471	Tongue 13 L Acc IEC 60471	ERGFR	HTV	HDGFS
	GSCC010/01	Spain	300067	CS 70 EB 125/900-455	24	50	125	900	210	E (65mm/kV)	455 ± 10	70	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS
	GSCC010/02	Argentina	0106-0277	CS 70 CT 170/1250-555	36	70	170	1250	285	E (60mm/kV)	555 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/02	Brazil	990292	CS 70 CT 170/1250-555	36	70	170	1250	285	E (60mm/kV)	555 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/02	Chile	300017	CS 70 CT 170/1250-555	36	70	170	1250	285	E (60mm/kV)	555 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
	GSCC010/02	Spain	300068	CS 70 EB 170/1250-555	36	70	170	1250	285	E (60mm/kV)	555 ± 10	70	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS
	GSCC010/03	Colombia	300011	CS 70 CT 210/1250-555	36	95	210	1250	365	E (60mm/kV)	555 ± 10	70	Clevis 16 L Acc IEC 60471 (*)	Tongue 16 L Acc IEC 60471 (*)	ERGFR	HTV	HDGFS
For existing lines	GSCC010/04	Spain	300031	CS 100 EB 125/835-455	24	50	125	835	350	E (60mm/kV)	455 ± 10	100	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS
	GSCC010/05	Spain	300033	CS 100 EB 170/1250-555	36	70	170	1250	450	E (60mm/kV)	555 ± 10	100	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS
For special uses (birdlife protection)	GSCC010/06	Spain	530699	CS 70 EB 125/835-400	24	50	125	835	350	E (60mm/kV)	400 ± 10	70	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS
	GSCC010/07	Spain	300020	CS 70 EB 170/1250-1150	36	70	170	1250	1000	E (60mm/kV)	1150 ± 10	70	Eye 24 Acc IEC 61466-1, D	Ball 16 Acc IEC 60120	ERGFR	HTV	HDGFS

(*) Also accepted 16N acc IEC 61466-1, annex B

Table 3 String insulators for MV lines

Use	Global code	Country	Country code	Designation	Material maximum voltage (U_m) [kV]	Wet Power frequency withstand voltage [kV]	Dry Lighting impulse withstand voltage [kV]	Minimum creepage distance [mm]	Minimum arcing distance [mm]	Pollution level	MDCL Maximum Design Cantilever Load [kN]	SCL Specific Cantilever Load [kN]	Core material	Housing material	Fitting material	Insulator length (bolt not considered) [mm]	Tie top size	Bolt length [mm]	Bolt diameter (outside insulator)
For new and existing lines	GSCC010/08	Argentina	0106-0276	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-345	Tie-top 73	200	M16
	GSCC010/08	Brazil	990291	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-345	Tie-top 73	200	M16
	GSCC010/08	Colombia	300010	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-345	Tie-top 73	200	M16
	GSCC010/08	Chile	300015	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-345	Tie-top 73	200	M16
	GSCC010/08	Peru	300018	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS *	300-345	Tie-top 73	200	M16
	GSCC010/09	Argentina	0106-0275	CLP 5-170NRN-1120	36	70	170	1120	285	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-380	Tie-top 100	200	M16
	GSCC010/09	Brazil	990294	CLP 5-170NRN-1120	36	70	170	1120	285	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-380	Tie-top 100	200	M16
	GSCC010/09	Chile	300014	CLP 5-170NRN-1120	36	70	170	1120	285	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-380	Tie-top 100	200	M16
	GSCC010/10	Colombia	300012	CLP 5-210NRN-1120	36	95	210	1120	365	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-380	Tie-top 100	200	M16
For special uses (attached on top)	GSCC010/24	Colombia	300029	CLP 5-125NRN-745 (special support)	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-345	Tie-top 73	Special top support	See drawing
	GSCC010/25	Colombia	300028	CLP 5-210NRN-1120 (special suport)	36	95	210	1120	365	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	300-380	Tie-top 100	Special top support	See drawing
For existing lines	GSCC010/11	Italy	300003	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	320-350	Tie-top 57	140	M22
	GSCC010/12	Romania	300003	CLP 5-125NRN-745	24	50	125	745	210	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	320-350	Tie-top 73	140	M22
	GSCC010/13	Spain	300064	CLP 5-170NRN-1120	36	70	170	1120	285	E (53,7 mm/kV)	5	10	ERGFR	HTV	HDGFS	380-460	Tie-top 57	120	M20
For special uses (protected creepage distance)	GSCC010/14	Brazil	300644	CLP 6-160NRN-560	24	70	160	560	241	D (41 mm/kV)	6	12,5	ERGFR / ceramic	HTV	HDGFS or ceramic	300-330	Tie-top 73	200	M16
	GSCC010/15	Brazil	300714	CLP 6-200NRN-1116	36	95	200	1120	311	E (53,7 mm/kV)	6	12,5	ERGFR / ceramic	HTV	HDGFS or ceramic	300-380	Tie-top 100	200	M16

(*) The head could be in ceramic material as per Enel request

Table 4 Line post insulators for MV lines-bare conductors

Subject: Global Infrastructure and Networks – GSCC010 Composite Insulators for Medium Voltage Lines

Application Areas
Perimeter: *Global*
Staff Function: -
Service Function: -
Business Line: *Infrastructure & Networks*

Global code	Country	Country code	Designation	Material maximum voltage (U_m) * [kV]	Wet Power frequency withstand voltage [kV]	Dry Lighting impulse withstand voltage [kV]	Minimum creepage distance [mm]	Minimum arcing distance [mm]	Pollution level	MDCL Maximum Design Cantilever Load	SCL Specific Cantilever Load [kN]	Core material	Housing material	Fitting material (head)	Fitting material (bolt)	Insulator length (bolt not considered) [mm]	Tie top size	Bolt length [mm]	Bolt diameter (outside insulator)
GSCC010/16	Argentina	0106-0279	CLP 5-95NRN-300 (for CC, short bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	60	M16
GSCC010/16	Brazil	300032	CLP 5-95NRN-300 (for CC, short bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	60	M16
GSCC010/16	Colombia	300027	CLP 5-95NRN-300 (for CC, short bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	60	M16
GSCC010/16	Chile	300022	CLP 5-95NRN-300 (for CC, short bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	60	M16
GSCC010/17	Brazil	300031	CLP 5-145NRN-385 (for CC, short bolt)	24	50	145	385	240	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 260	Tie-top 73	60	M16
GSCC010/17	Chile	300023	CLP 5-145NRN-385 (for CC, short bolt)	24	50	145	385	240	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 260	Tie-top 73	60	M16
GSCC010/18	Brazil	300030	CLP 5-170NRN-575 (for CC, short bolt)	36	70	170	575	285	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 300	Tie-top 100	60	M16
GSCC010/19	Colombia	300026	CLP 5-210NRN-575 (for CC, short bolt)	36	95	210	575	365	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 300	Tie-top 100	60	M16
GSCC010/20	Colombia	300025	CLP 5-95NRN-300 (for CC, long bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	200	M16
GSCC010/20	Chile	300021	CLP 5-95NRN-300 (for CC, long bolt)	17,5	38	95	300	160	B (29,7 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 200	Tie-top 73	200	M16
GSCC010/21	Chile	300020	CLP 5-145NRN-385 (for CC, long bolt)	24	50	145	385	240	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 260	Tie-top 73	200	M16
GSCC010/23	Colombia	300024	CLP 5-210NRN-575 (for CC, long bolt)	36	95	210	575	365	B (27,8 mm/kV)	5	10	ERGFR	HTV	resin compatible with covered conductor from GSCC021	HDGFS	≤ 300	Tie-top 100	200	M16

(*) Material maximum voltage as per IEC, equivalent to IEEE: 17,5 kV eq to 15 kV, 24 kV eq to 26,2 kV and 36 kV eq to 36,2 kV
Note: maximum housing diameter of 140 mm and minimum diameter at the metallic support of 90 mm

Table 5 Line post insulators for MV lines-covered conductors

7.2 APPLICABLE LAWS AND REFERENCE STANDARD

Reference documents listed below (amendments included) shall be the edition in-force at the contract date.

7.2.1 International standard

- CIGRE 33-204: Considerations on the design of composite suspension insulators based on experience from natural ageing testing and electric field calculations.
- IEC 60071-1: Insulation co-ordination - Part 1: Definitions, principles and rules.
- IEC 60071-2: Insulation co-ordination - Part 2: Application guide.
- IEC 60383-1: Insulators for overhead lines with a nominal voltage above 1000 V - Part 1: Ceramic or glass insulator units for a.c. systems - Definitions, test methods and acceptance criteria. (Zinc Coating Test).
- IEC 60383-2: Insulators for overhead lines with a nominal voltage above 1000 V - Part 2: Insulator strings and insulator sets for a.c. systems – Def, test methods and acceptance criteria.
- IEC 60587: Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion.
- IEC 60695-11-10: Fire hazard testing - Part 11-10: Test flames - 50 W horizontal and vertical flame test methods.
- IEC 60815-1: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 1: Definitions, information and general principles.
- IEC 60815-3: Selection and dimensioning of high-voltage insulators intended for use in polluted conditions - Part 3: Polymer insulators for a.c. systems.
- IEC 61109: Insulators for overhead lines - Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria.
- IEC 61621: Dry, solid insulating materials - Resistance test to high-voltage, low-current arc discharges.
- IEC 61466 -1: Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V - Part 1: Standard strength classes and end fittings.
- IEC 61466 -2: Composite string insulator units for overhead lines with a nominal voltage greater than 1000 V - Part 2: Dimensional and electrical characteristics.
- IEC 61952: Insulators for overhead lines - Composite line post insulators for A.C. systems with a nominal voltage greater than 1 000 V - Definitions, test methods and acceptance criteria
- IEC 61952-1: Insulators for overhead lines – Composite line post insulators for AC systems with a nominal voltage greater than 1 000 V – Part 1: definitions, end fittings and designations
- IEC 62631: Dielectric and resistive properties of solid insulating materials.

- IEC TS 62073: Technical Specification: Guidance on the measurement of wettability of insulator surfaces.
- IEC 62217: Polymeric HV insulators for indoor and outdoor use - General definitions, test methods and acceptance criteria.
- ISO 1461: Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methods.
- ISO 34-1: Rubber, vulcanized or thermoplastic -- Determination of tear strength -- Part 1: Trouser, angle and crescent test pieces.
- ISO 37: Rubber, vulcanised or thermoplastic. Determination of tensile stress-strain properties
- ISO 868: Plastics and ebonite - Determination of indentation hardness by means of a durometer (Shore hardness)
- ISO 2781: Rubber, vulcanized or thermoplastic — Determination of density
- IEC/TR 62662: Guidance for production, testing and diagnostics of polymer insulators with respect to brittle fracture of core materials (and its Spanish transposition to UNE-CLC/TR62662 IN)
- IEC/TR 62730 HV: polymeric insulators for indoor and outdoor use tracking and erosion testing by wheel test and 5000h test.

7.2.2 Enel standards

- MAT-O&M-NCS-2021-0033-EGIN version 3 “Global Infrastructure and Networks – GSCG002 Technical Conformity Assessment”.
- Contractual Requirements for Components and Materials Quality management.
- CNS-O&M-S&L-2021-0032-EGIN “Global Infrastructure and Networks Barcode specification.
- Packaging, transport, and delivery requirements rev.2.

7.2.3 Laws

Brazil

- NR-10 – Segurança em instalações e serviços em eletricidade.

Chile

- Reglamento de seguridad de las instalaciones eléctricas destinadas a la producción, transporte, prestación de servicios complementarios, sistemas de almacenamiento y distribución de energía eléctrica y todos sus Pliegos Técnicos

Colombia

- RETIE – Reglamento Técnico de Instalaciones Eléctricas.

Perú

- CNE – Código Nacional de Electricidad – Suministro 2011.

Italy

- D.Lgs n. 81 of the 9th of April 2008 and subsequent modifications.
- Nota Operativa PVR001 – Rev. 2 – Ott. 2012 - Gestione Garanzie dei materiali di ENEL Distribuzione.

Spain

- R.D. 614/2001, de 8 de junio, sobre disposiciones mínimas para la protección de la salud y seguridad de los trabajadores frente al riesgo eléctrico.
- R.D. 337/2014, de 9 de mayo, por el que se aprueban el Reglamento sobre condiciones técnicas y garantías de seguridad en instalaciones eléctricas de alta tensión y sus Instrucciones Técnicas Complementarias ITC-RAT 01 a 23.
- R.D. 223/2008, de 15 de febrero, por el que se aprueban el Reglamento sobre condiciones técnicas y garantías de seguridad en líneas eléctricas de alta tensión y sus instrucciones técnicas complementarias ITC-LAT 01 a 09.

Romania

- NTE 001/03/00 – Normativ privind alegerea izolației, coordonarea izolației și protecția instalațiilor electroenergetice împotriva supratensiunilor
- NTE 003/04/00 – Normativ pentru construcția liniilor electrice aeriene de energie electrică cu tensiuni peste 1000 V

7.2.4 Local replaced standards

Argentina

- E-MT-011

Brazil

- E-MT-011
- NTU AES-002
- NTU AES-006
- Standard drawings MP-06-22 and MP-06-23

Colombia

- E-MT-011

Chile

- E-MT-011

Italy

- String insulators: DJ 511
- Line post insulators: DJ 502

Perú

- E-MT-011

Romania

- String insulators: DJ 511 RO
- Line post insulators: DJ502/2 RO

Spain

- String insulators: AND012
- Line post insulator: 6704113/300043

7.3 SERVICE CONDITIONS

The service conditions to be considered for the material included in this standard are:

- Maximum Ambient Air Temperature: + 50 ºC.
- Minimum Ambient Air Temperature: - 40 ºC.
- Maximum relative humidity: 95%. For higher values see IEC 60071-1 and IEC 60071-2.
- Maximum altitude above mean sea level: 1.000 m (*). For higher values see IEC 60071-1 and IEC 60071-2
- Maximum solar radiation: 1.000 W/m^2

7.3.1 Specific service conditions for Colombia

Maximum reference altitude for Colombia	2.700 m

Table 6 Service Conditions

Note: Insulation capacity depends on these service conditions, for Colombia it will be considered the reference altitude in the selection of the electrical characteristics.

7.4 TECHNICAL CHARACTERISTICS

7.4.1 Mechanical Load

7.4.1.1 String insulators: Specific Mechanical Load (SML)

String insulators shall have a specific mechanical load of 70 kN.

Spain shall maintain two codes with SML equal a 100 kN for their use in pre-existing lines dimensioned with this load.

7.4.1.2 Line post insulators: Specific Cantilever Load (SCL)

Line post insulators shall have a specific cantilever load, SCL, of 10 kN. The SCL is the bending load that can be supported by the insulator when tested under the prescribed conditions.

The maximum design cantilever load, MDCL, is defined as the load level above which the core begins to be damaged and is the last limit of loads in service. According to IEC 61952-1, the MDCL may be as much as 50% of the SCL (5 kN as maximum).

The bolt shall be designed to support the specific cantilever load of the insulator.

7.4.2 Electrical requeriments

7.4.2.1 Standarized insulation levels

The standardized insulation levels are specified according to IEC 60071-1:

Material maximum voltage, U_m [kV]	Power frequency withstand voltage [kV]	Lighting impulse withstand voltage [kV]
24	50	125
	50	145**
36	70	170
	95*	210*

Table 7 Insulations levels

(*) Values for Colombia including the correction for altitude.

(**) Value for composite line post insulators for covered conductor.

7.4.2.2 Creepage distance and arcing distance

The creepage distance is the shortest distance along the insulator surface between conductive parts of both sides of the insulator which support the service voltage.

The minimum creepage distance of an insulator depends on its maximum material voltage and the pollution level. Standard IEC 60071-2 refers to IEC 60815 series to get a value for this minimum creepage distance.

Based on this, the Global Standard stablishes a level E for the site pollution severity for bare conductor lines, with a value of RUSCD equal to 60 mm/kV for 36 kV string insulators, 65 mm/kV for 24 kV string insulators and 53,7 mm/kV for line post insulators (some exclusions apply to special insulators). For covered conductor lines, it is defined a level B, (27,8 mm/kV).

On the other hand, the minimum arcing distance (shortest distance in the air between conductive parts of both sides of the insulator which support the service voltage) is related to the lighting impulse withstand voltage.

Standard IEC 61466-2 shows a table relating the insulation level and the minimum arcing distance for standardized composite string insulators. The values stablished for our insulators must be:

Material maximum voltage U_m [kV]	**Lighting impulse withstand voltage [kV]**	**Minimum arcing distance [mm]**
24	125	210
	145 * *	240
36	170	285
	210 *	365

Table 8 Arcing distance

(*) Value for Colombia

(**) Value for composite line post insulators for covered conductor.

7.5 CONSTRUCTION CHARACTERISTICS

7.5.1 Composite insulators construction

This standard defines polymeric composite insulators for their general use on the lines from MV network of Enel Group.

A composite insulator consists of three important parts:

- Dielectric Insulator Core
- Hydrophobic insulation housing
- Fittings

As a polymeric insulator, the insulating body consists of at least one organic based material.

The insulator shall be designed and assembled to ensure that no moisture, water or external substances reach the core.

7.5.1.1 Dielectric Insulator Core

It transmits the mechanical stresses produced by conductors to the support and provides the necessary electrical insulation.

Material

Epoxy resin resistant to hydrolisys reinforced with glass fiber resistant to corrosion in order to prevent the risk of brittle fractures (ERGFR).

7.5.1.2 Hydrophobic insulation housing

The hydrophobic insulation housing (sheath and sheds) protects the core from external agents providing sealing and preventing the formation of a continuous film of water. The protection given by the housing shall be guaranteed without the need of any secondary sealing. The hydrophobic insulation housing minimum thickness is 3mm. In the triple junction point, where the core meets the metal coupling and the silicone-rubber coating ends, the insulation housing thickness shall not be less than 4 mm. The housing will cover the junction between the core and the fittings.

The housing provides the necessary creepage distance in order to get the required insulation of the core surface.

In order to facilitate the integration with the environment the colour of the silicone-rubber shall be gray. Other different colour shall be approved by Enel.

Material

Sheath and sheds shall be silicone-rubber (VMQ - Vinyl-Methyl-Polysiloxane, with filler additives) free of EPDM or other natural origin rubbers.

Silicone rubber

Silicone-rubber shall be **HTV solid silicone type (High Temperature Vulcanized – solid silicone rubber).** This type of silicone rubber is solid and vulcanizes at a high temperature (near 200ºC).

Two fabrication processes are allowed for the silicone rubber, molding process or by assembling modules.

The characteristics of the silicone rubber are described in the table below:

Mechanical characteristics	Standard	Minimum value HTV	
Density	ISO 2781	1,5	[g/cm³]
Hardness	ISO 868	65	Shore A
Breaking stress	ISO 37	3,5	[N/mm²]
Breaking elongations	ISO 37	200	[%]
Tear strength	ISO 34-1	12	[N/mm²]

Table 9 Silicone properties

At every existing interface from the composite insulator, the adhesion strength of the interface (interface resistance) shall be higher than the tear strength of the silicone.

Silicone-rubber of insulators shall have a resistance to tracking and electric erosion with a classification of Class 1A 4,5 according to IEC 60587 and shall resist the effects of corona discharges and ozone. It shall withstand a low-current arc discharge for more than 300 seconds under the conditions indicated in standard IEC 61621 and its volume resistivity shall be over 10^{10} Ω·m according to IEC 62631.

The silicone-rubber must be type V0 according to the IEC 60695-11-10.

Additionally the silicone rubber shall have highly hydrophobic features and shall be classified type WC1 as specified in IEC TS 62073.

7.5.1.3 Fittings

The fittings transmit the mechanical stress from the ends of the core to the support and to the conductor.

The electrical field strength is concentrated in the triple junction point, so the fabrication process shall be careful in this point. The connection zone must be water and air sealed to ensure the total enclosure of the insulator.

The end fittings shall be directly attached to the core by radial or circumferential compression process for a better load distribution.

The end fittings shall be only assembled by the insulator manufacturer, during the manufacturing process.

Material

Hot dip galvanized forged steel, for very high pollution:

- Minimum for individual sample: 720g/m², equivalent to 100μm
- Minimum for the average of the whole sample: 865 g/m², equivalent to 120μm

For the tie-top head of line post insulators for covered conductors it shall be used a resin material compatible with our covered conductors, defined in GSCC021 and resistant to UV radiation *(other solutions will be valued)*.

7.5.1.4 Type of end fitting for string insulators

String insulators are those whose end fittings are suitable for flexible attachment to other similar string insulator units or to connecting accessories.

String insulator shall present different fittings depending on the country. The fittings are according the reference given in standard IEC 61466-1.

Clevis –tongue

This type of fitting is used in Argentina, Brazil, Colombia, Chile and Peru:

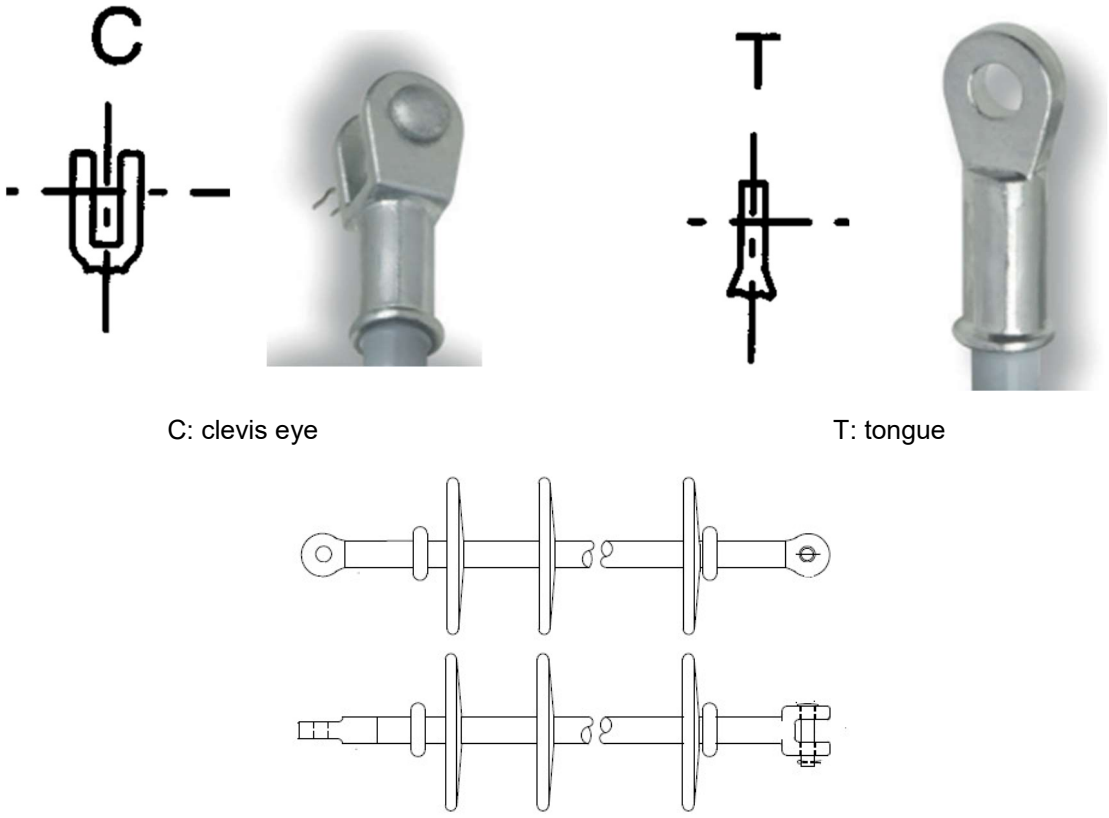


Image 1. Fittings for string insulators, clevis and tongue

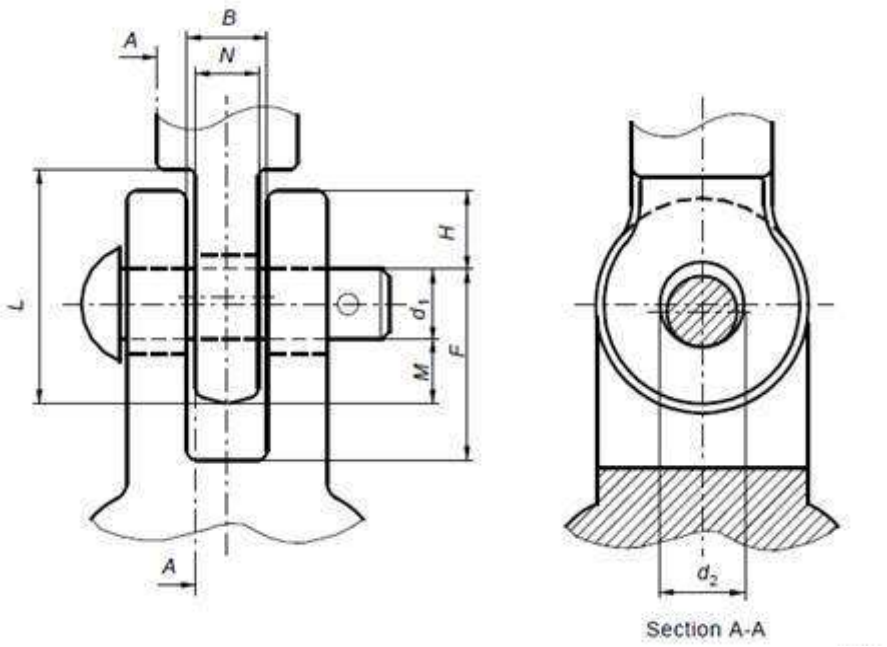


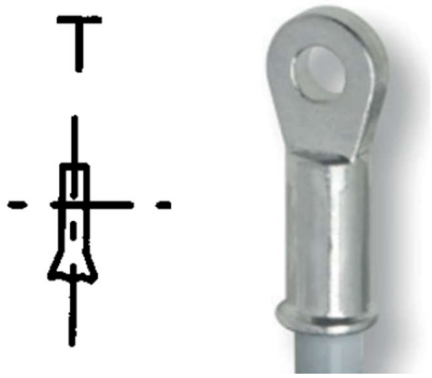
Image 2. Clevis and tongue dimensional scheme

		IEC 60471			IEC 61466-1 (optional)		
		16L			16N		
		Used in Argentina, Brazil, Colombia, Chile and Peru					
		min	nom	max	min	nom	max
Coupling pin diameter	d1	15,5	16	16,3	15,5	16	16,3
Hole of clevis and tongue	d2	16,7	17,5	18,3	16,7	17,5	18,3
Tongue thickness	N	15	16	17	-	-	14,3
Clevis opening	B	18	18	20	17,5	-	-
Tongue	M	12	15	18	-	-	14,3
Clevis	F	38,5	-	41	32,9	-	-
Clevis	H	-	-	19	-	-	16,5
Tongue	L	55	-	-	48	-	-

Table 10. Clevis and tongue dimensions

Tongue –tongue

This type of fitting is used in Italia and Romania:



T: tongue

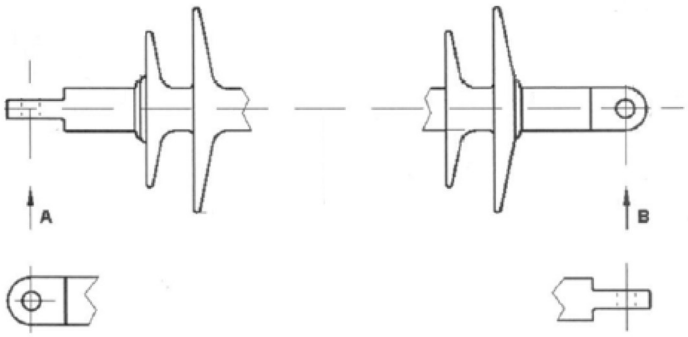


Image 3. Fittings for string insulators, tongue – tongue

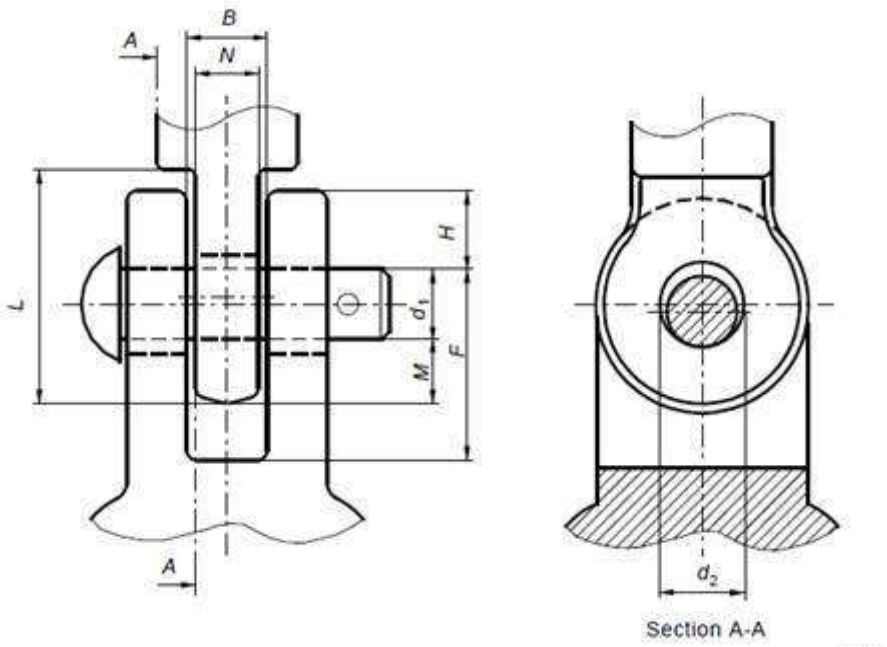


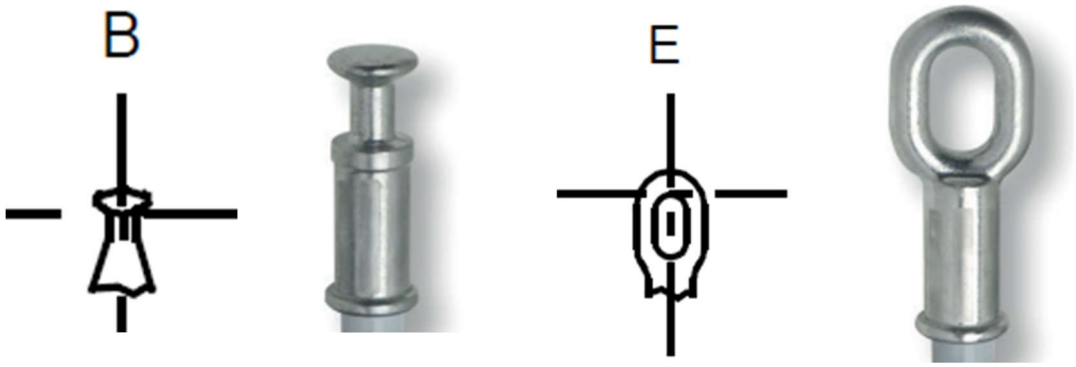
Image 4. Tongue dimensional scheme

		IEC 60471		
		13L		
		Used in Italy and Romania		
		min	nom	max
Coupling pin diameter	d1	12,8	13	13,5
Hole of clevis and tongue	d2	14	14	15
Tongue thickness	N	12	13	13,5
Tongue	M	10	13	15
Tongue	L	45	-	-

Table 11. Tongue dimensions

Eye – ball

This type of fitting is used in Spain:



B: ball E: eye

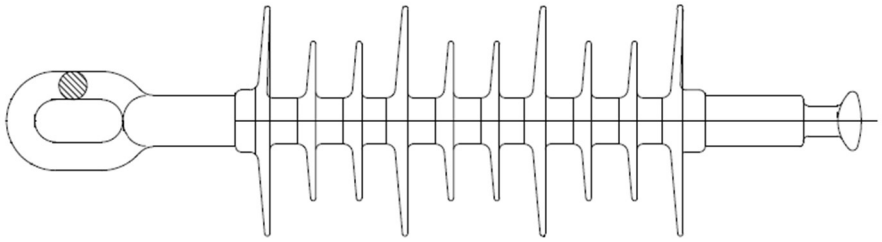


Image 5 Fittings for string insulators, eye and ball

Spain

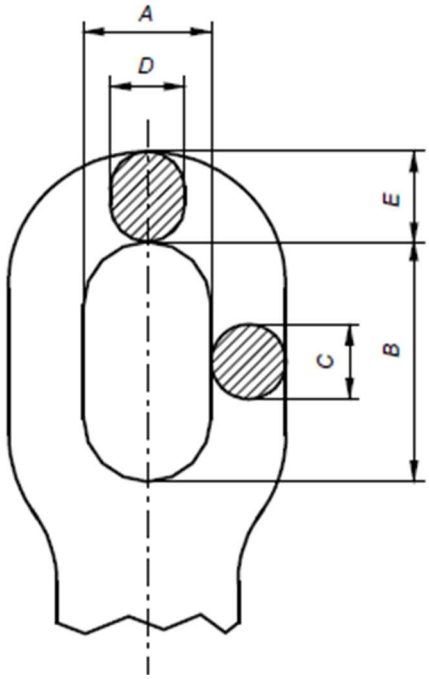


Image 6. Eye dimensional scheme

Designation		24	
Dimensions [mm]		Min.	Max.
Width of eye	A	24	-
Length of eye	B	48	-
Shank	C	-	19
Shoulder	D	-	19
Head	E	-	19

Table 12. Eye dimensions according IEC61446-1 annex D

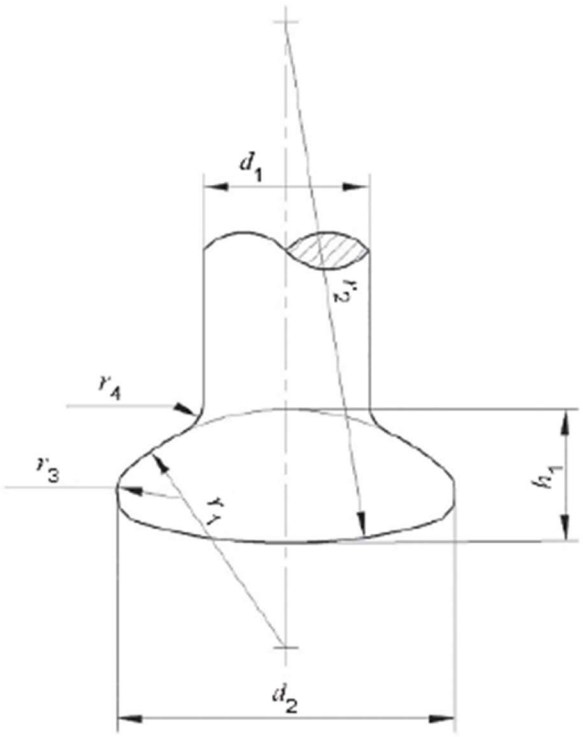


Image 7. Ball dimensional scheme

Designated size of coupling	d_1	d_2	h_1	r_1	r_2	r_3 (*)	r_4
16	$17{,}0^{0}_{-1{,}2}$	$33{,}3^{0}_{-1{,}5}$	$13{,}4^{0}_{-1{,}3}$	23,0	50,0	3,0	$3{,}0^{+1}_{-0{,}5}$

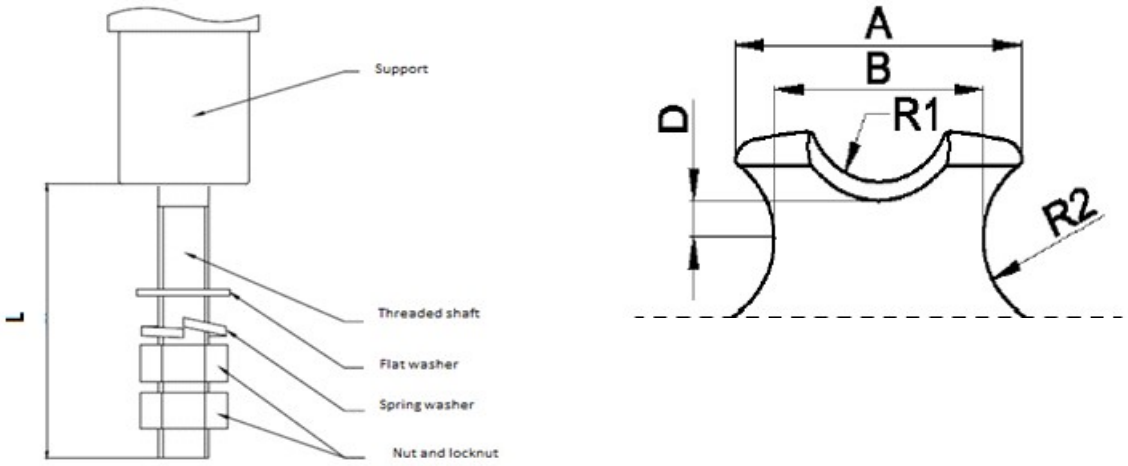
(*) r3 only for guidance

Table 13. Ball dimensions according IEC 60120

7.5.1.5 Type of end fitting for line post insulators

Line post insulators are those rigid insulators intended to be subjected to cantilever, tensile and compressive loads, constructed with one or more insulating materials and assembled on a metal base that is intended to be mounted rigidly on a supporting structure

Line post insulators shall present a tie-top head fitting. The insulator has a support where the bolt is attached. There is no additional base:



Support and bolt Tie-top head

Image 8. Fittings for line post insulators

The length of the bolt is defined in the common list table.

Head Nominal dimensions [mm]	Type of head		
	Tie top 57	Tie-top 73	Tie-top 100
A	57	73	100
B	44 ± 3	57 ± 3	73 ± 3
R1	13-18	25	25
D	18 ± 4	18 ± 4	17 ± 3
R2	13-18	25	25

Table 14 Head dimensions

Due to the particular climatic conditions in Rumania, the head shall include a through hole adapted to the constructive solution, diameter 19 mm, as shown in the figure:

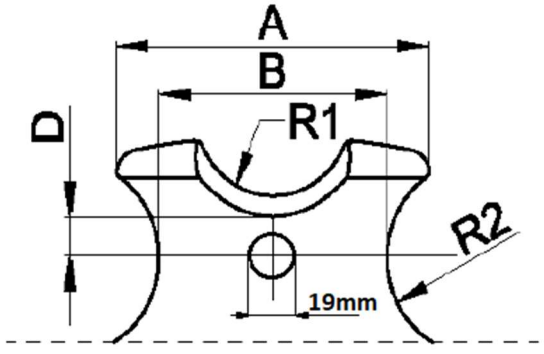
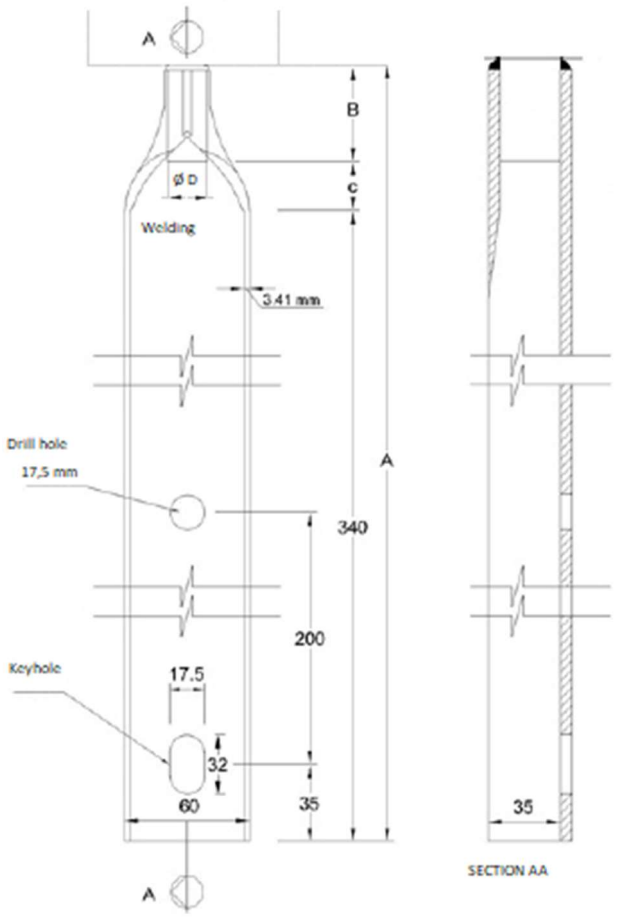


Image 9 Tie top head for Romania

Global types GSCC010/24 and GSCC010/25 have a special support to be mounted directly on the top of the pole with the following design:

Note, all dimensions in mm



[mm]	For 24 kV	For 36 kV
A	449	549
B	79	169
C	30	40
D	16	19

Image 10 special support for the top of the pole

This special support shall also be done on hot dip galvanized forged steel (type SAE 1010 or SAE 1020), with a tensile strength of 340 MN/m², minimum fluency of 180 MN/m² and 30% of elongation in 50 mm. It is composed of two parts, the support with a rod and a curved steel plate welded to the rod. It shall support a bending moment of an orthogonal load of 6,7 kN and a longitudinal load of 5,4 kN (angle 10º), torsion by a wrench torque of 17 Nm and 180 º rotation and also strength load test with a strength load of 13,35 kN.

Regarding to the particular conditions in Perú, the head of line post insulators for bare conductor lines could be offered in ceramic material as requested per ENEL. Then it shall be required the porosity test for the ceramic head as described in ANSI C29.7.

The end fittings shall be only assembled by the insulator manufacturer, during the manufacturing process. The bolt could be solidly forged with the support, or it could be considered the solution of two pieces forged separately, but always assembled in origin, joined with an additional resin compatible with the steel or equivalent system and completely fixed so it cannot be disassembled even with the aim of any tool. For Spain it shall only be accepted the solution of support and bolt forged in one piece.

The thread shall cover the entire length of the bolt in order to assure that the insulator can be used in all type of cross-arms.

7.5.1.6 Special designs: line post insulator with protected creepage distance

Global type designs GSCC010/16 and GSCC010/17 are a special design for a line post insulator with protected creepage distance used in some specific zones where classic design has some problems with the contamination.

The housing shall be in polymeric material as defined previously and the core shall be made of glass fiber reinforced resin or ceramic material.

The head shall have the same dimensions previously defined and could be of ceramic or hot dip galvanized forged steel.

When this insulator uses ceramic as material, it will be considered a hybrid insulator and it will be asked the specific porosity test for the ceramic as defined per ANSI C29.7.

The minimum protected creepage distance shall be 280 mm.

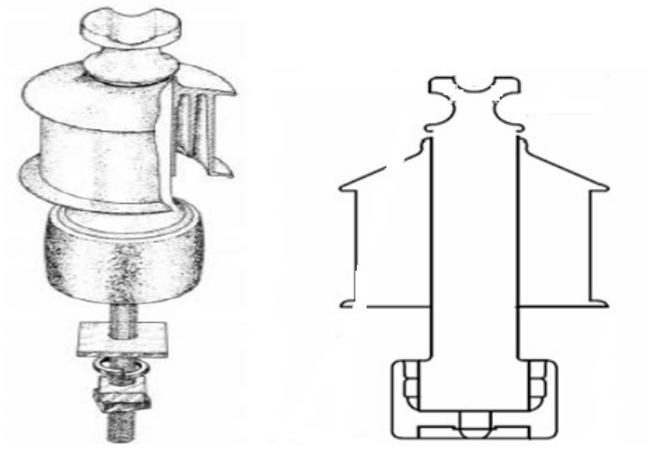


Image 11 Protected creepage distance line post insulator

7.5.1.7 Special designs: string insulators with specific characteristics for bird life protection

Global types GSCC010/06 and GSCC010/07 are designed due to special legal requirements related to the bird life protection in Spain.

GSCC010/06 has been designed for its use in vault-type support structures located in areas of bird protection when the distance between the top of the pole and the central conductor makes it necessary.

GSCC010/07 is designed to be used when it is needed a greater distance between the cross-arm and the conductor for bird protection, including special star form sheds designed to avoid birds alighting in the line (bird protection element).

This “bird protection” element will have the form of a four-pointed star with a blunt end, inscribed in a circle with a diameter of approximately 130mm and centered on the axis of the insulator. The “bird protection” elements will be obtained from the same molding process of the sheds of the insulator and from the same material. See an example in the next image:

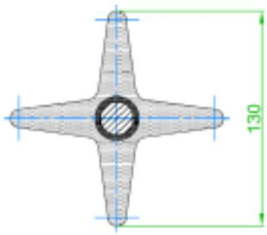


Image 12. Star shed scheme for 300020 code

This code shall have a minimum of 5 standard round sheds distributed homogeneously along the whole length and it shall also include bird protection elements avoiding the birds to remain, distributed along the insulator. Each section of 50 mm shall include a standard shed or bird protection element at least.

This insulator shall have a maximum creepage line of 1350 mm and an insulated length of 1000 mm.

7.5.2 Other dimensions

7.5.2.1 Total length

String insulators

The total length considered from considered between the union points with the other elements from the insulating chain is defined in the common list.

Line post insulators

The total length phase-ground considered from the support without the bolt until the top of the insulator is defined in the common list.

7.5.2.2 Maximum diameter

String insulators

According to IEC 61466, the maximum diameter from the isolating zone of the string insulators is 200 mm.

Line post insulators

The line post insulator designed for covered conductor (global codes GSCC010/16 to 23) shall have a maximum housing diameter of 140 mm and a minimum diameter at the metallic support of 90 mm.

7.5.3 Quality issues

The technical conformity of a particular design of composite insulator strings shall be determined by accomplishing design tests, type tests, sample tests and routine test related in this document, but, additionally, it is recommended that manufacturers take into account the conclusions given in the document CIGRÉ 33-204. This document include some recommendations related to parting lines when removing the insulator from the mould, distance between last shed and end fitting or the connection zone between core, end fitting and housing.

On the other hand, IEC TS 60815-3 contains gives specific guidelines and principles of the behaviour of an insulator in certain pollution environment. This guideline would be recommended in this type of situations.

Finally, IEC/TR 62662 is a technical report which gives guidance for production, testing and diagnostics of polymer insulators with respect to brittle fracture of core materials.

7.6 DESIGNATION

7.6.1 String insulators

The composite string insulators are designated as follows (see IEC 61466-1 and 2):

- Letters CS (composite string)
- Specific Mechanic Load in kN
- Two letters representing both end fittings, first one for pole/ground side, second one for the conductor/tension side.
- Two numbers separated by a slash, the first one represents the lighting impulse withstand voltage in kV and the second one the minimum creepage distance in mm
- A dash followed by the total length in mm (this last information doesn’t appear in the IEC 61466)

7.6.2 Line post insulators

Line post insulators are designated as follows:

- Letters CLP (composite line post)
- Maximum Design Cantilever Load in kN followed by a dash.
- Lighting impulse withstand voltage in kV
- Letters NRN (to designate the fittings N for tie-top, R for stud and N because there is no base) followed by a dash
- Minimum creepage distance in mm
- In line post insulators for covered conductors, it shall be added “(for CC, short/long bolt)” at the end

7.6.3 Designation Example

CS 70 EB 125/600-455

Composite string insulator, Specific mechanic load equal to 70 kN, with an eye for the support-side and a ball for the conductor side, lighting impulse withstand voltage equal to125 kV and minimum creepage distance of 600 mm. Total length equal to 455 mm.

CLP5-170NRN-1120

Composite line post insulator, Maximum design cantilever load equal to 5 kN (which means SCL equal to 10 kN) , lighting impulse withstand voltage equal to 170 kV, with a “tie-top” coupling for the conductor side (the head) and a stud or bolt for the support-side, without basis and minimum creepage distance of 1120 mm.

7.7 MARKING

Each insulator shall be clearly and indelibly marked as specified in IEC 62217, indicating:

- The name or trademark of the manufacturer.
- The year of manufacture.
- The specified mechanical load (SML) / Maximum Design Cantilever Load (MDCL) – kN.
- Manufacturer reference for the insulator.
- Material maximum voltage

7.8 TESTING

The composite insulators must be designed and tested according the standards IEC 62217 (for all types of polymeric insulators), IEC 61109 (only for string composite insulators) and IEC 61952 (only for line post composite insulators).

Tests are divided into four groups:

- Design tests
- Type tests
- Sample tests (Acceptance Tests)
- Routine tests

Design and Type tests are performed once, during the TCA process.

Sample tests shall be carried out on every singular purchased lot, as an acceptance tests.

Routine tests shall be carried out individually, on every composite insulator.

7.8.1 Design Tests

These tests are intended to verify the suitability of the designs, materials and methods of manufacture (technology).

The design of a composite insulator is defined by:

- Core and housing materials and their manufacturing method.
- When needed, end fitting material, design and method of attachment (excluding the other fittings of the string).
- Thickness of the core housing.
- Core diameter.

The design tests are described in the table below, the table includes the tests from the IEC 62217 and some additional tests:

Tests			Generic	String insulators	Line post insulators
Tests on interfaces and connections of end fittings	Pre-stressing		IEC 62217, 9.2.5	Consult particularities in IEC 61109	Consult particularities in IEC 61952
	Water immersion pre-estressing		IEC 62217, 9.2.6		
	Verification tests	Visual test	IEC 62217, 9.2.7		
		Steep front impulse voltage test	IEC 62217, 9.2.7		
		Dry power frequency voltage test	IEC 62217, 9.2.7		
Tests on sheds and housing material	Hardness test		IEC 62217, 9.3.1		
	Accelerated weathering test		IEC 62217, 9.3.2		
	Tracking and erosion test		IEC 62217, 9.3.3		
	Flammability test		IEC 62217, 9.3.4		
Tests on the core material	Porosity test (dye penetration test)		IEC 62217, 9.4.1		
	Water diffusion test		IEC 62217, 9.4.2		
Assembled core load-time test	Determination of the average failing load of the core of the assembled insulator				
	Control of the slope of the strength-time curve of the insulator				
Additional tests on housing material	Density		ISO 2781		
	Breaking stress		ISO 37		
	Breaking elongation		ISO 37		
	Tear strength		ISO 34-1		
	Tracking and erosion test		IEC 60587 (sample taken from the shed of the insulator)		
	Volume resistivity		IEC 62631		
	Low current arc discharge		IEC 61621		
	Silicone thickness (shed and triple point)		IEC 61109 and IEC 61952		
	Silicone Fingerprint (DSC, TGA and FTIR)		Cigre Brochure 595 2014, WG D1.27, Fingerprinting of Polymeric Insulating Materials for outdoor use		
	Hydrofobicity		IEC TS 62073		
Additional tests on connections	Galvanizing test		IEC60383-1		
Additional test on the core	Test on resistance of core against stress corrosion		Described in this standard		
Screening test	Tracking and erosion test on tracking wheel		IEC/TR 62730		

Table 15. Design tests for string and line post composite insulators

Note: The UV accelerated weathering test shall be done on the whole insulator.

According to IEC 62217, when a polymeric insulator is submitted to the design tests described in this table, it becomes a parent insulator for a design class, and the test results shall be considered valid for the whole class. This insulator parent defines a design class which have the following characteristics:

- Same materials for the core and housing and same manufacturing method
- Same material of the end fittings, the same design and the same method of attachment
- Same or greater minimum layer thickness of the housing over the core (including a sheath where used)

When changes occur in the design, some of these tests shall be repeated according to the recommendations in tables from IEC 61109 and 61952.

7.8.1.1 Additional test on the core: Test on resistance of core against stress corrosion

This test will be performed at ambient temperature to confirm the mechanical resistance against corrosion stress of the core. It is done according to the indications of the IEC Project 36-6-2 of WG 36-07 through the Spanish transposition of the IEC/TR 62662 (UNE-CLC/TR62662 IN).

Test specimen

It will be used an insulator from the production line or a specimen with length between end fittings of at least 10 times the core. When using a specimen different to the insulator to homologate, the diameter of the core will be the same of the insulator or inferior. The end fittings shall be identical to those used in the production.

The test is executed in the bare part of the rod, so the housing must be removed in the middle part of the insulator in a minimum length of 150 mm. The visible core surface has to be smoothed by means of a fine abrasive cloth (grain size 180). Remaining parts of the housing have to be completely removed. An acid container made of polyethylene shall be arranged surrounding the visible core surface in such a way that the liquid can simply be poured into the container and no acid comes into contact with the end fittings. The size of the acid container shall be adapted in such a way that the core is surrounded by a liquid thickness not less than 1 cm and a liquid level of not less than 4 cm. The container shall be covered to prevent liquid evaporations greater than 5% of its volume during the test period.

Performance of the test

The insulator must be subjected to a tensile load applied between the metal parts along the test. The tensile load must be increased rapidly but regular, from zero up to 70% of the specified mechanical load (SML for SC insulators, STL for CLP insulators) and then must be maintained at this value for 96 h. Immediately after applying the load, a nitric acid of 1N concentration must be poured into the acid container (i.e. 1 N = 63,01 g HNO_3 per litre of solution). The acid must not come into contact with the end fittings.

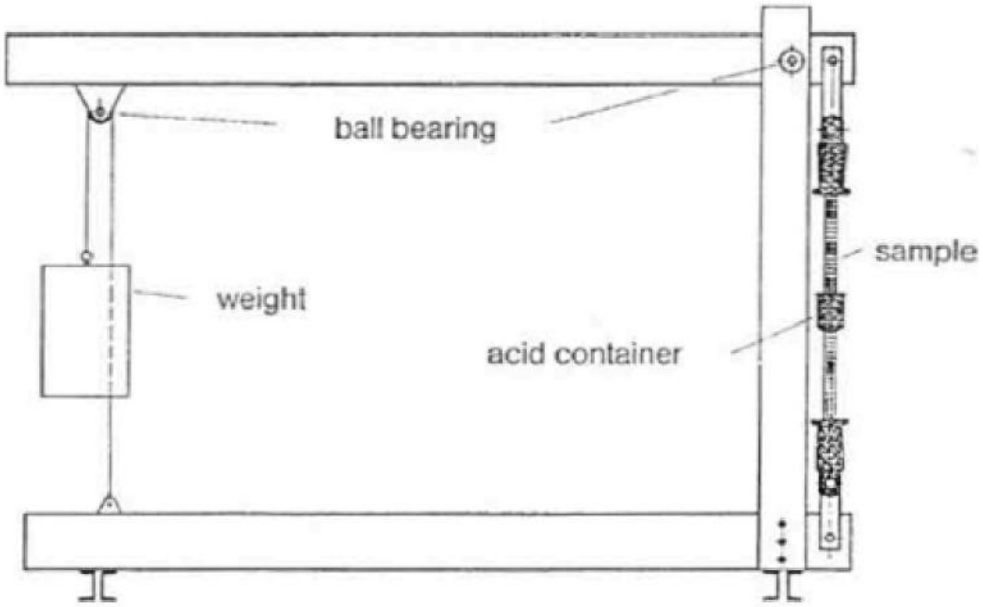


Image 13. Scheme for test about the resistance of core against stress corrosion

Test evaluation

The test is passed if no fracture of the core occurs during the 96 h. test (no failures occur, and macroscopic inspection reveals no damage or change in the composite after the exposure).

Additional tracking and erosion screening test

Insulators shall be tested according to an additional screening test for tracking and erosion. For this purpose it shall be considered the tracking wheel test as described in IEC/TR 62730.

7.8.2 Type tests

An insulator is defined electrically by the arcing length, creepage distance and the housing profile (inclination, diameter and spacing of sheds). On the other hand, the main mechanical characteristic is the SML o SCL for a specific insulator (depending on core diameter, method of attachment and coupling design).

Type tests shall be applied to composite insulators belonging to an already qualified design class. The type tests shall be repeated only when the type of the composite insulator is changed. The parameters defining a type of composite insulator and the applicable type tests are given in the relevant product standard.

According to specific standards IEC 61109 and 61952, type tests are:

Tests string insulator		Standard
Mechanical characteristics	Damage limit proof test and test of the tightness of the interface between end fittings and insulator housing	IEC 61109 11.2
Electrical characteristics	Dry lighting impulse withstand voltage test	IEC 61109 11.1
	Wet power frequency test	IEC 61109 11.1

Table 16. Type tests for string insulators

Test line post insulator		Standard
Mechanical characteristics	Cantilever failing load test	IEC 61952 11.2
Electrical characteristics	Dry lighting impulse withstand voltage test	IEC 61952 11.1
	Wet power frequency test	IEC 61952 11.1

Table 17. Type tests for line post insulators

7.8.3 Sample tests (Acceptance tests)

Sample tests (Acceptance tests) are intended to verify characteristics of a composite insulator, including those which depend on the quality of the manufacturing process and the materials used.

The tests will be done to sample groups E1 and E2. The material will be selected at random.

N (lot size)	Sample size	
	E1	E2
N≤300	3	2
300<N≤2000	4	3
2000<N≤5000	8	4
5000<N≤10000	12	6

Table 18. Sample size for Acceptance tests

For lot sizes bigger than 10.000 insulators, the lot will be divided into an optimum number of lots comprising between 2.000 and 10.000 insulators. The results of the tests shall be evaluated separately for each lot.

The acceptance tests shall be performed autonomously by the manufacturer for each produced batch.

In case of acceptance test attended by Enel, the tests shall be repeated on a reduced amount of insulators equal to 50% of that originally provided (table 10), rounded to the lower unit; in case of negative outcome of even a single sample (on a single test) the batch shall be rejected.

Test String insulators	Sample	Standard
Verification of general dimensions	E1+E2	IEC 61109, 12.2
Verification of silicon thickness (shed and triple point)	E2	GSCC010, 7.1.2
Verification of the end fittings	E2	IEC 61109, 12.3
Verifications of tightness of the interface between end fittings and insulator housing	E2	IEC 61109, 12.4
Verifications of the specified mechanical load, SML	E1	IEC 61109, 12.4
Galvanizing test	E2	IEC 61109, 12.5
Housing material density	E2	ISO 2781
Tracking and erosion (sample from a shed)	E2	IEC 60587

Table 19. Acceptance tests (sample tests) for string insulators

Test Line post insulators	Sample	Standard
Verification of dimensions	E1+E2	IEC 61952, 12.2
Verification of silicon thickness (shed and triple point)	E2	GSCC010, 7.1.2
Galvanizing test	E1+E2	IEC 61952, 12.3
Verifications of cantilever load test	E1	IEC 61952, 12.4
Housing material density	E2	ISO 2781
Tracking and erosion (sample from a shed)	E2	IEC 60587

Table 20. Acceptance tests (sample tests) for line post insulators

7.8.4 Routine tests

The aim of these tests is to eliminate composite insulators with manufacturing defects. They shall be made on every composite insulator offered for acceptance.

Test string insulators	Standard
Mechanical routine test	IEC 61109, 13.1
Visual examination	IEC 61109, 13.2

Table 21. Routine tests for string insulators

Test line post insulators	Standard
Tensile load test	IEC 61952, 13.1
Visual examination	IEC 61952, 13.2

Table 22. Routine tests for line post insulators

7.9 TECHNICAL CONFORMITY ASSESSMENT

Local Certifications

For Colombia, RETIE certification shall be also provided according to local regulation (see 2.1).

7.10 GUARANTEE

Requirement of warranty will be indicated in the request for bids, indicating periods and standards, although any material will be warrantied 24 months as a minimum.

7.11 CONDITIONS OF SUPPLY

Manufacturers of insulators shall provide appropriate instructions, documents showing sample and routine tests and information covering general conditions during transport, storage and installation of the insulators. The documents must be in the local language of the destiny country. Enel will have the power to verify that the instructions given are in line with the standard practices in the sector.

The line post insulators will be supplied with all the necessary elements for its correct fixation to the pole (flat washer, optional flat square washer, spring washer, nut and lock nut). The instructions shall indicate the torque to be applied.

The instructions shall also include the information about how to segregate the components of the device at the end of its life.

Insulators of the same batch must be packed in wood crates or hard cardboard boxes. Every box shall be marked with a code selected by the manufacturer for the purpose of identifying the fabrication lot, the type of insulator (insulators marking, as described in this document) and the quantity. These marks must be indelible and resistant to weathering under severe weather conditions during transport and storage.

They shall be securely packaged to prevent insulators to touch each other and to avoid any damage to sheds during storing, loading and transportation. Specific supports shall be needed to immobilize the insulators.

The insulators shall be packed in lots of 3, and each box shall contain a maximum of 60 insulators. They all shall be of the same type.

The consistency of the boxes shall permit a three-ply storage/transportation and they shall be prepared for handling by forklift trucks and by boom cranes. They also must be treated to prevent degradation over time.

The requirements regarding dimensions for delivery to ENEL deposits are reported in Packaging, transport and delivery requirements.

Package dimension shall be in compliance with the standard EN 13698-1 for loading palettes 80x120 cm.

7.12 TECHNICAL CHECK LISTS

7.12.1 String insulators

Item	Description	Unit	Value	Deviation GSCC010
1	**GENERAL INFORMATION**			
1.1	Supplier	-		
1.2	Factory	-		
1.3	Location of factory	-		
2	**MAIN FEATURES**			
2.1	Distribution Company and Country	-		
2.2	Country Code	-		
2.3	GS Type Code	-	GSCC010/xx	
2.4	Designation	-		
2.5	Supplier reference	-		
2.6	Drawing	-		
2.7	Maximum system voltage Um	[kV]		
2.8	Dry lightning impulse withstand voltage	[kV]		
2.9	Wet power frequency withstand voltage	[kV]		
2.10	Specified mechanical load (SML)	[kN]		
2.11	Routine test load (RTL)	[kN]		
2.12	Pollution level (IEC 60815-1)	-		
2.13	Creepage distance	[mm]		
2.14	Arcing distance	[mm]		
2.15	Section length	[mm]		
2.16	Weight	[kg]		
2.17	Marking	-		
3	**FITTINGS**			
3.1	Material	-		
3.2	Type of assembling	-		
3.3	Type of fitting tower side	-		
3.4	Size of fitting tower side	-		
3.5	Type of fitting conductor side	-		
3.6	Size of fitting conductor side	-		
3.7	Hot dip galvanized	[g/m^2]		
4	**CORE *informative***			
4.1	Material	-		
4.2	Nominal diameter (without housing)	[mm]		
4.3	Length of rod	[mm]		

4.4	Glass transition temperature	[ºC]		
4.5	Volume resistivity	[Ω · m]		
5	**HOUSING**			
5.1	Material	-		
5.2	Tear strength	[N/mm]		
5.3	Resistance to tracking class	-		
5.4	Fire resistance class type	-		
5.5	LOI	[%]		
5.6	Hydrophobic classification type	-		
5.7	Volume resistivity	[Ω · m]		
5.8	Minimum thicknes of housing over the core	[mm]		
5.9	Color	-		
6	**SHEDS PROFILE *informative***			
6.1	Material	-		
6.2	Manufacturing process	-		
6.3	Number of sheds (large-small)	-		
6.4	Diameter of shed (large-small)	[mm]		
6.5	Shed to shed spacing	[mm]		
6.6	Shed overhang (large-small)	[mm]		
6.7	Minimun distance between sheds	[mm]		
6.8	Shed angle (large-small)	[º]		
6.9	Thickness at base (large-small)	[mm]		
6.10	Thickness at tip (large-small)	[mm]		
7	**PACKING**			
7.1	Material of crates	-		
7.2	Insulators per crate	[Units]		
7.3	Ready for handling by forklift and boom crane	-		
8	**NOTES**			

Table 23. Check list for string insulators

7.12.2 Line post insulators (Composite)

Item	Description	Unit	Value	Deviation GSCC010
1	**GENERAL INFORMATION**			
1.1	Supplier	-		
1.2	Factory	-		
1.3	Location of factory	-		
2	**MAIN FEATURES**			
2.1	Distribution Company and Country	-		
2.2	Country Code	-		
2.3	GS Type Code	-	GSCC010/xx	
2.4	Designation	-		
2.5	Supplier reference	-		
2.6	Drawing	-		
2.7	Maximum system voltage Um	[kV]		
2.8	Dry lightning impulse withstand voltage	[kV]		
2.9	Wet power frequency withstand voltage	[kV]		
2.10	Specific Cantilever Load	[kN]		
2.11	Routine Tensile load test	[kN]		
2.12	Pollution level (IEC 6815-1)	-		
2.13	Creepage distance	[mm]		
2.14	Arcing distance	[mm]		
2.15	Section length	[mm]		
2.16	Weight	[kg]		
2.17	Marking	-		
3	**FITTINGS**			
3.1	Material bolt	-		
3.2	Type of assembling	-		
3.3	Length bolt	mm		
3.4	Bolt diameter	M		
3.5	Material head	-		
3.6	Head of insulator, dimension A	mm		
3.7	Head of insulator, dimension B	mm		
3.8	Head of insulator, dimension D	mm		
3.9	Head of insulator, dimension R1	mm		
3.10	Head of insulator, dimension R2	mm		
3.11	Hot dip galvanized	[g/m^2]		
4	**CORE *informative***			
4.1	Material	-		
4.2	Nominal diameter (without housing)	[mm]		

4.3	Length of rod	[mm]		
4.4	Glass transition temperature	[ºC]		
4.5	Volume resistivity	[Ω · m]		
5	**HOUSING**			
5.1	Material	-		
5.2	Tear strength	[N/mm]		
5.3	Resistance to tracking class	-		
5.4	Fire resistance class type	-		
5.5	LOI	[%]		
5.6	Hydrophobic classification type	-		
5.7	Volume resistivity	[Ω · m]		
5.8	Minimum thicknes of housing over the core	[mm]		
5.9	Color	-		
6	**SHEDS PROFILE *informative***			
6.1	Material	-		
6.2	Manufacturing process	-		
6.3	Number of sheds (large-small)	-		
6.4	Diameter of shed (large-small)	[mm]		
6.5	Shed to shed spacing	[mm]		
6.6	Shed overhang (large-small)	[mm]		
6.7	Minimun distance between sheds	[mm]		
6.8	Shed angle (large-small)	[º]		
6.9	Thickness at base (large-small)	[mm]		
6.10	Thickness at tip (large-small)	[mm]		
7	**PACKING**			
7.1	Material of crates	-		
7.2	Insulators per crate	[Units]		
7.3	Ready for handling by forklift and boom crane	-		
8	**NOTES**			

Table 24. Check list for line post insulators

7.13 TESTS REQUIRED FOR TECHNICAL CONFORMITY ASSESSMENT PROCESS

7.13.1 Tests for string insulators

#	Technical specification reference	IEC		Test Description		est applicabil	Test Report reference				Applicability report		
							Name	Laboratory	Date	Name and revision of technical specification and/or standard referenced in the test report	Name	Rev.	Date
	GSCC010 9.1.1	IEC 62217, 9.2.5		*Tests on interfaces and connections of end fittings*	Pre-stressing								
	GSCC010 9.1.1	IEC 62217, 9.2.6			Water immersion pre-estressing								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Visual test								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Steep front impulse voltage test								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Dry power frequency voltage test								
	GSCC010 9.1.1	IEC 62217, 9.3.1		*Tests on sheds and housing material*	Hardness test								
	GSCC010 9.1.1	IEC 62217, 9.3.2			Accelerated weathering test								
	GSCC010 9.1.1	IEC 62217, 9.3.3			Tracking and erosion test								
	GSCC010 9.1.1	IEC 62217, 9.3.4			Flammability test								
	GSCC010 9.1.1	IEC 62217, 9.4.1		*Tests on the core material*	Porosity test (dye penetration test)								
	GSCC010 9.1.1	IEC 62217, 9.4.2			Water diffusion test								
	GSCC010 9.1.1	IEC 61952		*Assembled core load-time test*	Determination of the average failing load of the core								
	GSCC010 9.1.1	IEC 61953			Control of the slope of the strength-time curve of the								
	GSCC010 9.1.1	ISO 2781		*Additional tests on housing material*	Density								
	GSCC010 9.1.1	ISO 37			Breaking stress								
	GSCC010 9.1.1	ISO 37			Breaking elongation								
	GSCC010 9.1.1	ISO 34-1			Tear strength								
	GSCC010 9.1.1	ISO 60587			Tracking and erosion test								
	GSCC010 9.1.1	IEC 62631			Volume resistivity								
	GSCC010 9.1.1	IEC 61621			Low current arc discharge								
	GSCC010 9.1.1	IEC 61952			Silicone thickness (shed and triple point)								
	GSCC010 9.1.1	Cigre 595			Silicone fingerprint								
	GSCC010 9.1.1	IEC 61621			Hydrofobicity								
	GSCC010 9.1.1	IEC 60383-1		*Additional test on connections*	Galvanizing Test								
	GSCC010 9.1.1	GSCC010		*Additional test on the core*	Test on resistance of core against stress corrosion								
	GSCC010 9.1.1	IEC/TR 62730	Design Tests	*Screening test*	Tracking and erosion test on tracking wheel								
	GSCC010 9.1.2	IEC 61109		Mechanical characteristics	Damage limit proof test and test of the tightness of the interface between end fittings and insulator housing								
	GSCC010 9.1.2	IEC 60383-2		Electrical characteristics	Dry lighting impulse withstand voltage test								
	GSCC010 9.1.2	IEC 60383-2	Type tests		Wet power frequency test								

Table 25 Test for string insulators

7.13.2 Tests for line post insulators (composite)

#	Technical specification reference	IEC		Test Description		est applicabil	Test Report reference				Applicability report		
							Name	Laboratory	Date	Name and revision of technical specification and/or standard referenced in the test report	Name	Rev.	Date
	GSCC010 9.1.1	IEC 62217, 9.2.5		*Tests on interfaces and connections of end fittings*	Pre-stressing								
	GSCC010 9.1.1	IEC 62217, 9.2.6			Water immersion pre-estressing								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Visual test								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Steep front impulse voltage test								
	GSCC010 9.1.1	IEC 62217, 9.2.7			Dry power frequency voltage test								
	GSCC010 9.1.1	IEC 62217, 9.3.1		*Tests on sheds and housing material*	Hardness test								
	GSCC010 9.1.1	IEC 62217, 9.3.2			Accelerated weathering test								
	GSCC010 9.1.1	IEC 62217, 9.3.3			Tracking and erosion test								
	GSCC010 9.1.1	IEC 62217, 9.3.4			Flammability test								
	GSCC010 9.1.1	IEC 62217, 9.4.1		*Tests on the core material*	Porosity test (dye penetration test)								
	GSCC010 9.1.1	IEC 62217, 9.4.2			Water diffusion test								
	GSCC010 9.1.1	IEC 61952		*Assembled core load-time test*	Test for the verifications of the maximum design cantilever load								
	GSCC010 9.1.1	IEC 61953			Tensile load test								
	GSCC010 9.1.1	ISO 2781		*Additional tests on housing material*	Density								
	GSCC010 9.1.1	ISO 37			Breaking stress								
	GSCC010 9.1.1	ISO 37			Breaking elongation								
	GSCC010 9.1.1	ISO 34-1			Tear strength								
	GSCC010 9.1.1	ISO 60587			Tracking and erosion test								
	GSCC010 9.1.1	IEC 62631			Volume resistivity								
	GSCC010 9.1.1	IEC 61621			Low current arc discharge								
	GSCC010 9.1.1	IEC 61952			Silicone thickness (shed and triple point)								
	GSCC010 9.1.1	Cigre 595			Silicone fingerprint								
	GSCC010 9.1.1	IEC TS 62073			Hydrofobicity								
	GSCC010 9.1.1	IEC 60383-1		*Additional test on connections*	Galvanizing Test								
	GSCC010 9.1.1	GSCC010		*Additional test on the core*	Test on resistance of core against stress corrosion								
	GSCC010 9.1.1	IEC/TR 62730	Design Tests	*Screening test*	Tracking and erosion test: Tracking wheel								
	GSCC010 9.1.2	IEC 61952 11.2		Mechanical characteristics	Cantilever failing load test								
	GSCC010 9.1.2	IEC 61952 11.1		Electrical characteristics	Dry lighting impulse withstand voltage test								
	GSCC010 9.1.2	IEC 61952 11.1	Type tests		Wet power frequency test								

Table 26 Test for line post insulator

7.14 OLD TO NEW CODES CONVERSION MATRIX

7.14.1 Codes conversion matrix for string insulators

GS code	Country	Country code	Designation	Material maximum voltage (U_m) [kV]	Country code GSCC010 V2		Other local specifications	
GSCC010/01	Argentina	0106-0278	CS 70 CT 125/900-455	24			0106-0072	0106-0074
GSCC010/01	Brazil	990293	CS 70 CT 125/900-455	24	6772263	321293	321291	
GSCC010/01	Colombia	300013	CS 70 CT 125/900-455	24	300546		300526	300524
GSCC010/01	Chile	300016	CS 70 CT 125/900-455	24	300130			
GSCC010/01	Italy	300002	CS 70 TT 125/900-455	24	301873	301874		
GSCC010/01	Peru	300019	CS 70 CT 125/900-455	24	300517			
GSCC010/01	Romania	300002	CS 70 TT 125/900-455	24	301873	301874		
GSCC010/01	Spain	300067	CS 70 EB 125/900-455	24	300092			
GSCC010/02	Argentina	0106-0277	CS 70 CT 170/1250-555	36				
GSCC010/02	Brazil	990292	CS 70 CT 170/1250-555	36	6794539	321292		
GSCC010/02	Chile	300017	CS 70 CT 170/1250-555	36	300221			
GSCC010/02	Spain	300068	CS 70 EB 170/1250-555	36	300032			
GSCC010/03	Colombia	300011	CS 70 CT 210/1250-555	36	300538		300523	
GSCC010/04	Spain	300031	CS 100 EB 125/835-455	24	300031			
GSCC010/05	Spain	300033	CS 100 EB 170/1250-555	36	300033			
GSCC010/06	Spain	530699	CS 70 EB 125/835-400	24	530699			
GSCC010/07	Spain	300020	CS 70 EB 170/1250-1150	36	300020			

Table 27 String insulators, code conversion matrix

7.14.2 Codes conversion matrix for composite line post insulators

a) Insulators for bare conductor lines

Global code	Country	Country code	Designation	Material maximum voltage (U_m) [kV]	Country code GSCC010 V2		Other local specifications			
GSCC010/08	Argentina	0106-0276	CLP 5-125NRN-745	24						
GSCC010/08	Brazil	990291	CLP 5-125NRN-745	24	6785764	321297	6785764 with bolt 6795830	321297 with bolt 325809	321323 with bolt 328509	
GSCC010/08	Colombia	300010	CLP 5-125NRN-745	24	300548	300545	300527 with bolt 201012	300536 with bolt 201012	300527 with bolt 201072	300536 with bolt 201072
GSCC010/08	Chile	300015	CLP 5-125NRN-745	24	300161		300124 with bolt 240055	300124 with bolt 240056		
GSCC010/08	Peru	300018	CLP 5-125NRN-745	24	300516					
GSCC010/09	Argentina	0106-0275	CLP 5-170NRN-1120	36						
GSCC010/09	Brazil	990294	CLP 5-170NRN-1120	36	4545811	321296	4545811 with bolt 6795830	321296 with bolt 328509		
GSCC010/09	Chile	300014	CLP 5-170NRN-1120	36	300220		300126 with bolt 240054	300126 with bolt 240053		
GSCC010/10	Colombia	300012	CLP 5-210NRN-1120	36	300547	300544	300520 with bolt 201014	300537 with bolt 201014	300520 with bolt 201073	300537 with bolt 201073
GSCC010/24	Colombia	300029	CLP 5-125NRN-745 (special support)	24			300527 with bolt 201019	300536 with bolt 201019		
GSCC010/25	Colombia	300028	CLP 5-210NRN-1120 (special support)	36			300520 with bolt 201015	300537 with bolt 201015		
GSCC010/11	Italy	300003	CLP 5-125NRN-745	24	301875	301876				
GSCC010/12	Romania	300003	CLP 5-125NRN-745	24	300001	630271				
GSCC010/13	Spain	300064	CLP 5-170NRN-1120	36	300043					
GSCC010/14	Brazil	300644	CLP 6-160NRN-560	24	6771058		6771058 with bolt 6795830			
GSCC010/15	Brazil	300714	CLP 6-200NRN-1116	36	T300030		T300030 with bolt 6795830			

Table 28 Line post insulators for bare conductor lines, code conversion matrix

b) Insulators for covered conductor lines

Global code	Country	Country code	Designation	Material maximum voltage (U_m) [kV]	Country code GSCC010 V2		Other local specifications	
GSCC010/16	Argentina	0106-0279	CLP 5-95NRN-300 (for CC, short bolt)	15			0106-0134	
GSCC010/16	Brazil	300032	CLP 5-95NRN-300 (for CC, short bolt)	15	321323		6772264 with bolt 6772141	321323 with bolt 328507
GSCC010/16	Colombia	300027	CLP 5-95NRN-300 (for CC, short bolt)	15			300536 with bolt 201072	
GSCC010/16	Chile	300022	CLP 5-95NRN-300 (for CC, short bolt)	15			300124 with bolt 240056	
GSCC010/17	Brazil	300031	CLP 5-145NRN-385(for CC, short bolt)	24			6783284 with bolt 6772141	321297 with bolt 328507
GSCC010/17	Chile	300023	CLP 5-145NRN-385 (for CC, short bolt)	24			300126 with bolt 240053	
GSCC010/18	Brazil	300030	CLP 5-170NRN-575 (for CC, short bolt)	36			6800637 with bolt 6772141	321296 with bolt 328507
GSCC010/18	Colombia	300026	CLP 5-210NRN-575 (for CC, short bolt)	36			300357 with bolt 201073	
GSCC010/20	Colombia	300025	CLP 5-95NRN-300 (for CC, long bolt)	17,5				
GSCC010/20	Chile	300021	CLP 5-95NRN-300 (for CC, long bolt)	17,5			300124 with bolt 240055	
GSCC010/21	Chile	300020	CLP 5-145NRN-385 (for CC, long bolt)	24			300126 with bolt 240054	
GSCC010/23	Colombia	300024	CLP 5-210NRN-575 (for CC, long bolt)	36				

Table 29 Line post insulators for covered conductor lines, code conversion matrix