

MATERIAL FOR OVERHEAD LINES

String insulator units made of ceramic or toughened-glass materials, of the cap and pin subtype, for Class 2 and 3 overhead power lines

Characteristics and testing

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0 INTRODUCTION

This document cancels and supersedes DMA C66-140/N (JUN 2008) edition 2.

The most important changes were as follows:

- Addition of flocking as an optional constituent of string insulator units;
- Radio interference test and residual strength test defined as compulsory type tests;
- Addition of zinc sleeve test and impact test as type tests;
- Addition of the radio interference test and zinc sleeve test as sampling tests;
- Addition of the thermal shock test as an individual test;
- Definition of wrapping and packaging requirements;
- Update of Annex A concerning the illustrative design of string insulator units;
- Addition of Annex B concerning the stipulated characteristics of string insulator units;
- Addition of Annex C concerning the summary of tests of string insulator units;
- Addition of Annex D concerning the assembly for carrying out the impact test;
- Addition of Annex E concerning the characteristics to be supplied and guaranteed by the manufacturer;
- Addition of Annex F concerning the test table;
- Addition of Annex G concerning the identification of products specified in this document.

1 AIM

The purpose of this document is to define the characteristics and tests of string insulator units, made from ceramic or toughened-glass material, of the cap and pin subtype, for bare conductors, medium voltage (MV) and high voltage (HV) overhead power lines to be purchased by E-REDES.

2 FIELD OF APPLICATION

This document applies to the three string insulators units with ball and socket couplings, listed in Table 1 below, and the respective five-unit short strings with no discharge rods.

The U 100 BLP string insulators are anti-pollution type units.

Table 1

String insulator units made of ceramic or toughened-glass materials, of the cap and pin subtype, short or long, with ball and socket couplings

String insulator unit reference according to IEC 60305 ⁽¹⁾	E-REDES string insulator unit reference	Ball and socket couplings according to IEC 60120	Electromechanical ⁽²⁾ or mechanical ⁽³⁾ failing load specified according to IEC 60383-1 (kN)
U 70 BS	U 70 BS	16A	70
U 100 BS	U 100 BS	16A	100
U 100 BLP	U 100 BLP	16A	100

1) IEC 60305 gives the reference characters of these string units the following meanings:
— letter U (to denote the insulator) followed by a number indicating in kN the specified electromechanical or mechanical failing load;
— letter B to indicate that it is a ball and socket coupling;
— letter S to indicate that the step is short;
— letter L to indicate that the step is long;
— letter P to indicate that the string has a long creepage distance (anti-pollution type insulator).

2) For insulators made of ceramic material.

3) For insulators made of toughened glass.

3 STANDARDS AND REFERENCE DOCUMENTS

This document includes provisions from other documents, referenced in the appropriate places in its text.

3.1 NP Standards

NP 1520: 1988	Isoladores eléctricos e seus acessórios. Isoladores de suporte. Isoladores de tensões superiores a 1 kV. Características gerais e ensaios
NP 2462: 1986	Isoladores eléctricos e seus acessórios. Isoladores de cadeia de fuste longo. Características gerais
NP 2626.471: 2009	Vocabulário Electrotécnico Internacional. Capítulo 471: Isoladores
NP 2833: 1986	Isoladores eléctricos e seus acessórios. Ensaio de isoladores de material cerâmico ou de vidro, para linhas aéreas de tensão nominal superior a 1000 V
NP 2879: 1997	Dispositivos de encravamento para ligações de bola e alvéolo de elementos de cadeias de isoladores
NP 2882: 1984	Isoladores eléctricos e seus acessórios. Isoladores de cadeia de campânula e espigão. Características gerais
NP 2884: 1984	Isoladores eléctricos e seus acessórios. Métodos de ensaio de perturbações radioeléctricas provenientes de isoladores de alta tensão
NP 2889: 1986	Isoladores eléctricos e seus acessórios. Isoladores de cadeia. Isoladores de linha de fuste maciço. Características gerais

NP 3126: 1995	Isoladores eléctricos e seus acessórios. Isoladores de cadeia. Método de ensaio para avaliação da resistência mecânica residual após danificação
NP 3523: 1991	Isoladores eléctricos e seus acessórios. Isoladores de linha rígidos de porcelana de eixo vertical com ferro de suporte, para tensões superiores a 1 kV. Características e ensaios
NP 3668: 1987	Isoladores eléctricos e seus acessórios. Guia para a escolha de isoladores em condições de poluição
NP 4366: 1997	Linhas eléctricas de alta tensão. Isoladores de linha rígidos de porcelana. Tipo horizontal
NP EN 10020:2002	Definição e classificação dos aços
NP EN 50341-1:2001	Linhas eléctricas aéreas de tensão superior a 45 kV c.a.. Parte 1: Requisitos gerais - Especificações comuns
NP EN 50341-2:2001	Linhas eléctricas aéreas de tensão superior a 45 kV c.a. Parte 2: Índice dos aspectos normativos nacionais
NP EN 50341-3:2001	Linhas eléctricas aéreas de tensão superior a 45 kV a.c.. Parte 3: Conjunto dos aspectos normativos nacionais

3.2 EN standards

EN 10020:2002	Definition and classification of grades of steel
EN 10027-1:2016	Designation systems for steels; steel names and principal symbols
EN 10027-2:2015	Designation systems for steel; numerical system
EN 10083-1:2006	Steels for quenching and tempering. Part 1: General technical delivery conditions
EN 10083-2:2006	Steels for quenching and tempering. Part 2: Technical delivery conditions for non-alloy steels
EN 10083-3:2006	Steels for quenching and tempering. Part 3: Technical delivery conditions for alloy steels
EN 10088-1:2014	Stainless steels. List of stainless steels
EN 10088-2:2014	Stainless steels. Technical delivery conditions for sheet/plate and strip of corrosion resisting steels for general purposes
EN 10088-3:2014	Stainless steels. Technical delivery conditions for semi-finished products, bars, rods, wire, sections and bright products of corrosion resisting steels for general purposes
EN 10130:2006	Cold rolled low carbon steel flat products for cold forming. Technical delivery conditions

EN 10228-1:2016	Non-destructive testing of steel forgings. Magnetic particle inspection
EN 12680-1:2003	Founding. Ultrasonic examination. Steel castings for general purposes
EN 12680-2:2003	Founding. Ultrasonic examination. Steel castings for highly stressed components
EN 12680-3:2011	Founding. Ultrasonic examination. Spheroidal graphite cast iron castings
EN 1369:2012	Founding. Magnetic particle inspection
EN 1370:2011	Founding. Surface roughness inspection by visual tactile comparators
EN 1371-1:2011	Founding. Liquid penetrant inspection. Sand, gravity die and low pressure
EN 1371-2:2015	Founding. Liquid penetrant inspection. Investment castings
EN 1559-1:2011	Founding. Technical conditions of delivery. General
EN 1559-3:2011	Founding. Technical conditions of delivery. Additional requirements for iron castings
EN 1560:2011	Founding. Designation system for cast iron. Material symbols and material numbers
EN 1562:2019	Founding. Malleable cast irons
EN 1563:2018	Founding. Spheroidal graphite cast iron
EN 50423-1:2005	Overhead power lines with a voltage exceeding 1 kV AC up to and including 45 kV AC. Part 1: General requirements - Common specifications
EN 50423-2:2005	Overhead power lines with a voltage exceeding 1 kV AC up to and including 45 kV AC. Part 2: Index of national standards aspects
EN 50423-3:2005	Overhead power lines with a voltage exceeding 1 kV AC up to and including 45 kV AC. Part 3: Set of national standard aspects

3.3 IEC Standards

IEC 60050-471: 2007	International Electrotechnical Vocabulary - Part 471: Insulators
IEC 60060-1: 2010	High-voltage test techniques. Part 1: General definitions and test requirements
IEC 60060-2: 2010	High-voltage test techniques. Part 2: Measuring Systems
IEC 60060-3: 2006	High-voltage test techniques - Part 3: Definitions and requirements for on-site testing
IEC 60120: 2020	Dimensions of ball and socket couplings of string insulator units
IEC 60168: 2001 Ed. 4.2 Consolidated Edition	Tests on indoor and outdoor post insulators of ceramic material or glass for systems with nominal voltages greater than 1000 V

IEC 60305: 2021	Insulators for overhead lines with a nominal voltage above 1000 V - Ceramic or glass insulator units for a.c. systems - Characteristics of insulator units of the cap and pin type
IEC 60372: 2020	Locking devices for ball and socket couplings of string insulator units: Dimensions and tests
IEC 60383-1: 2023	Part 1: Ceramic or glass insulator units for a.c. systems - Definitions, test methods and acceptance criteria
IEC 60383-2: 1993	Part 2: Insulator strings and insulator sets for a.c. systems - Definitions, test methods and acceptance criteria
IEC 60433: 2021	Characteristics of insulator units of the long rod type
IEC 60437: 1997	Radio interference test on high-voltage insulators
IEC 60471: 2020	Clevis and tongue couplings of string insulator units - Dimensions
IEC 60507: 2013	Artificial pollution tests on high-voltage insulators to be used on a.c. systems
IEC 60575: 1977	Thermal-mechanical performance test and mechanical performance test on string insulator units
IEC 60672-1: 1995	Ceramic and glass insulating materials. Part 1: Definitions and classification
IEC 60672-2: 1999	Specification for ceramic and glass insulating materials. Part 2: Methods of test
IEC 60672-3: 1997	Ceramic and glass insulating materials. Part 3: Specifications for individual materials
IEC 60720: 1981	Characteristics of line post insulators
IEC 60797: 1984	Residual strength of string insulator units of glass or ceramic material for overhead lines after mechanical damage of the dielectric
IEC 60815-1: 2008	Selection and dimensioning of high-voltage insulators for polluted conditions - Part 1: Definitions, information and general principles
IEC 60815-2:2008	Selection and dimensioning of high-voltage insulators for polluted conditions - Part 2: Ceramic and glass insulators for a.c. systems
IEC 60815-3:2008	Selection and dimensioning of high-voltage insulators for polluted conditions - Part 3: Polymer insulators for a.c. systems
IEC 61083-1:2021,	Instruments and software used for measurement in high-voltage and high-current tests - Part 1: Requirements for instruments for impulse tests
IEC 61109: 2008	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 61211: 2004	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1 000 V - Impulse puncture testing in air
IEC 61467: 2008	Insulators for overhead lines - Insulator strings and sets for lines with a nominal voltage greater than 1 000 V - AC power arc tests

3.4 ISO Standards

ISO 1460: 2020	Metallic coatings - Hot dip galvanized coatings on ferrous metals - Determination of the mass per unit area
ISO 1461: 2021	Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methods
ISO 1463: 2021	Metallic and oxide coatings — Measurement of coating thickness — Microscopical method
ISO 2064:1996	Metallic and other inorganic coatings — Definitions and conventions concerning the measurement of thickness
ISO 2178: 2016	Non-magnetic coatings on magnetic substrates. Measurement of coating thickness. Magnetic method
ISO 8601:2019	Data elements and interchange formats — Information interchange — Representation of dates and times

4 TERMS AND DEFINITIONS

The following terms and definitions apply to this document.

4.1 String insulator unit

Cap and pin insulator or long rod insulator of which the end fittings are suitable for flexible attachment to other similar string insulator units or to connecting accessories.

4.2 Insulator string

Two or more string insulator units coupled together and intended to give flexible support to overhead line conductors.

4.3 Insulator set

Assembly of one or more insulator strings suitably connected together, complete with end fittings and protective devices as required in service.

4.4 Flashover

Disruptive discharge external to the insulator, and over its surface, connecting those parts which normally have the operating voltage between them.

4.5 Puncture

Disruptive discharge passing through the solid insulating material of the insulator which produces a permanent loss of dielectric strength.

4.6 Dry lightning impulse withstand voltage

Dry lightning impulse withstood by the insulator under the prescribed test conditions.

4.7 50% dry lightning impulse flashover voltage

Value of the dry lightning impulse which, under the prescribed test conditions, has a 50% probability of causing an insulator flashover.

4.8 Wet power-frequency withstand voltage

Wet power-frequency withstood by the insulator under the prescribed test conditions.

4.9 50% wet power-frequency flashover voltage

Value of the wet power-frequency which, under the prescribed test conditions, has a 50% probability of causing an insulator flashover.

4.10 Industrial wet power-frequency withstand voltage

Industrial wet power-frequency voltage withstood by the insulator under the prescribed test conditions.

4.11 Industrial wet power-frequency flashover voltage

Arithmetic mean of the measured voltages causing the insulator to flashover under the prescribed test conditions.

4.12 Electromechanical failing load

Maximum load that can be achieved when a string unit is tested under the prescribed test conditions.

4.13 Mechanical failing load

Maximum load reached when an insulator is tested under the prescribed conditions of test.

4.14 Puncture voltage

Voltage that causes a string unit or rigid insulator to be punctured under the prescribed test conditions.

4.15 Creepage distance

shortest distance or the sum of the shortest distances along the surface on an insulator between two conductive parts which normally have the operating voltage between them.

4.16 Type tests

Tests required to be carried out prior to the supply of a type of string insulator unit meeting the respective standard, on a general commercial basis, in order to demonstrate satisfactory performance characteristics for the intended applications. They are tests of such a nature that, after they have been successfully carried out, need not be repeated, unless there are changes in the raw materials, design or manufacturing processes which entail a change in the performance characteristics of the type of string insulator unit.

4.17 Series tests (sampling and/or individual)

Tests performed during a product realisation cycle, at any of its stages, both in the form of individual tests and in the form of sample tests, to verify compliance with the respective technical specification of the presumed product characteristics depending on variations in industrial production.

4.18 Acceptance tests

Tests carried out by the manufacturer in the presence of the customer or a third entity acting on its behalf to verify the conformity of a supply with the applicable technical specification.

5 ACRONYMS AND ABBREVIATIONS

The following acronyms and abbreviations are used in this document:

HV	High voltage
DMA	Standard document for materials and apparatus – Characteristics and Tests
EN	European standard
IEC/ISO	International Electrotechnical Commission/International Standard Organization
MV	Medium voltage
NP	Portuguese standard (Norma Portuguesa)
U_m	Highest voltage for the equipment
U_n	Rated voltage

6 CHARACTERISTICS

Construction and design

String insulator units shall be made of materials specified in the following requirements¹⁾.

A sample configuration of the string insulator with dimensions and constituents is given in Annex A.

Requirement	Description
R001	Dielectric The dielectric material of string insulator units shall be ceramic material (C 110, C 120, C 130) or toughened glass (G 120). Applicable standards: IEC 60672-1, IEC 60672-2 and IEC 60672-3.
R002	Cap The material of the string insulator elements cap shall be malleable cast iron, or nodular cast iron, galvanised using the hot dip method. Applicable standards: EN 1562 and 1563.
R003	Cement The type of cement used in the string insulator unit must be declared. If the dielectric is made of ceramic material, the cement shall be of the Portland type.
R004	Other constituent units The string insulator unit may contain a flocked ring between the cap and the dielectric (optional requirement). If the unit contains the flocked ring, the material of the ring should be polyamide fibre. Other configurations may also be accepted by E-REDES upon submission of tests and evidence that ensure the integrity and good performance of the string insulator unit throughout its lifetime.
R005	Pin The material of the string insulator units' pin shall be forged steel, galvanised using the hot dip method. Applicable standards: EN 10083-1 and EN 10083-2.

1) *The use of materials other than those indicated requires prior agreement of E-Redes.*

R006	<p>Safety device</p> <p>The material of the string insulator units' cap shall be stainless steel (EN 1.4301 - AISI 304). Applicable standards: IEC 60372 and EN 10088-3.</p>
R007	<p>Glaze colour</p> <p>The glaze colour of the string insulator units shall be defined. The visible cement part shall be painted the same colour as the glaze.</p> <p>This requirement applies only to string insulator units in ceramic material.</p>

6.1 Dimensions and shapes

A sample configuration of the string insulator with dimensions and constituents is given in Annex A.

Requirement	Description
R008	<p>Maximum nominal diameter of the insulating part, D</p> <p>In accordance with Section 4 of IEC 60305 and the provisions of Table B1 of ANNEX B this document.</p>
R009	<p>Nominal spacing, P</p> <p>In accordance with Section 4 of IEC 60305 and the provisions of Table B1 of ANNEX B this document.</p>
R010	<p>Minimum nominal creepage distance, L</p> <p>In accordance with Section 4 of IEC 60305 and the provisions of Table B1 of ANNEX B this document.</p>
R011	<p>Standard coupling, d1</p> <p>In accordance with IEC 60120 and IEC 60305 and the provisions of Table B1 of ANNEX B this document.</p>
R012	<p>Dimensions of the balls of the pins and sockets of the caps</p> <p>The dimensions of the balls of the pins and the dimensions of the sockets of the caps shall be those corresponding to the connections according to IEC 60120, according to the provisions of Table B1 of Annex B to this document.</p>
R013	<p>Shape of safety devices</p> <p>In accordance with IEC 60372 and the provisions of Table B1 of ANNEX B this document.</p>
R014	<p>Safety device dimensions</p> <p>In accordance with IEC 60372.</p>

R015	<p>Dimensional tolerances</p> <p>The dimensions of the string insulator units and their components (dielectric, cap, pin and interlocking device) shall comply with the tolerances laid down in the manufacturer's designs and these shall in turn comply with the following ratios and values:</p> <ul style="list-style-type: none"> — tolerance on nominal diameter according to IEC 60383-1: <ul style="list-style-type: none"> — $\pm (0.04 d + 1.5)$ mm for $d \leq 300$ mm; — $\pm (0.025 d + 6)$ mm for $d > 300$ mm; — where the dimension is expressed in millimetres; — tolerance on the nominal step according to IEC 60305: $\pm (0.03 P + 0.3)$ mm, where P is the nominal step expressed in millimetres; — tolerance on the nominal creepage according to IEC 60383-1: $\pm (0.04 L + 1.5)$ mm where L is the length of the nominal creepage²⁾; — tolerances on ball pins and sockets: according to IEC 60120 (or NP-341: 1967). — tolerances on safety devices: according to IEC 60372.
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6.2 Mechanical and electrical characteristics

Requirement	Description
R016	<p>Specified electromechanical or mechanical failing load</p> <p>The values of the specified electromechanical or mechanical failing loads of the string units shall not be less than the provisions of Table B1 of ANNEX B this document.</p>
R017	<p>Specified industrial wet power-frequency withstand voltage – string unit</p> <p>For standard reference atmospheric conditions according to IEC 60060-1, the values of the specified industrial wet power-frequency withstand voltage of the string units, without discharge rods, shall not be lower than the provisions of Table B1 of Annex B to this document.</p>
R018	<p>Specified industrial wet power-frequency withstand voltage - short string with 5 units, without rods</p> <p>For standard reference atmospheric conditions according to IEC 60060-1, the values of the specified industrial wet power-frequency withstand voltage of short strings with 5 units, without discharge rods, shall not be lower than the provisions of Table B1 of Annex B to this document.</p>
R019	<p>Specified dry lightning impulse withstand voltage – string unit</p> <p>For standard reference atmospheric conditions according to IEC 60060-1, the values of the specified dry lightning impulse withstand voltage of the string units, without discharge rods, shall not be lower than the provisions of Table B1 of ANNEX B to this document.</p>
R020	<p>Specified dry lightning impulse withstand voltage – short string with 5 units, without rods</p> <p>For standard reference atmospheric conditions according to IEC 60060-1, the values of the specified dry lightning impulse withstand voltage of short strings with 5 units, without discharge rods, shall not be lower than the provisions of Table B1 of ANNEX B to this document.</p>

2) *The above negative tolerances shall apply to the length of the creepage, even if it is specified as the minimum nominal creepage.*

<p>R021</p>	<p>Withstand puncture voltage at industrial frequency</p> <p>The value of the specified withstand puncture voltage at the industrial frequency of each string unit shall not be less than that set out in Table B1 of ANNEX B this document.</p> <p>For each string unit, the ratio between the value of the specified withstand puncture voltage at industrial frequency and the value of the specified dry withstand voltage at industrial frequency³⁾ shall not be less than 1.65.</p>
<p>R022</p>	<p>Specified withstand puncture voltage in air</p> <p>String units shall meet the acceptance criteria set out in IEC 61211 for the test in air.</p>
<p>R023</p>	<p>Thermomechanical performance</p> <p>The string units shall meet the acceptance criteria set out in IEC 60383-1 for the thermomechanical performance test.</p>
<p>R024</p>	<p>Axial and radial displacements⁴⁾</p> <p>The axial and radial displacement of the dielectric from the axle line, including the lack of dielectric flatness and dielectric ovality, shall not exceed the following values according to IEC 60383-1:</p> <ul style="list-style-type: none"> — variation in A: 4% of the nominal diameter of the string unit; — variation in B: 3% of the nominal diameter of the string unit.
<p>R025</p>	<p>Manoeuvring force - Safety devices</p> <p>In manoeuvring the clips and W-shaped springs according to IEC 60383-1 in clause 22, the force F which causes the clip, or W-shaped spring, to pass from the interlocking position to the connecting position shall be within the values given in Table B1 of ANNEX B this document.</p>
<p>R026</p>	<p>Resistance to sudden temperature changes (only for ceramic material string units)</p> <p>At the end of the third cycle of the test for resistance to sudden temperature changes prescribed in Article 23.1 of IEC 60383-1, the ceramic material string units shall not display any crevice and shall subsequently pass the individual electrical test prescribed in Article 16 of the same standard.</p>
<p>R027</p>	<p>Thermal shock resistance (for toughened glass string units only)</p> <p>The toughened glass string units shall withstand the thermal shock test prescribed in IEC 60383-1 without the glass breaking.</p> <p>In this test, the toughened glass string units shall be dipped suddenly and entirely in water at a temperature of no more than 50 °C after being heated by hot air or other suitable means at a uniform temperature of at least 100 °C above the temperature of the water. The insulators shall remain in the water for at least two minutes.</p>
<p>R028</p>	<p>No porosity</p> <p>In the porosity test prescribed in section 25.1 of IEC 60383-1, the broken fragments at the end of the test shall not show any trace of dye penetration as prescribed in section 25.2 of the same standard.</p>
<p>R029</p>	<p>Galvanisation Quality</p> <p>The quality of galvanisation shall comply with the requirements of section 26 of IEC 60383-1.</p> <p>Galvanised metal parts shall have mass values of zinc of not less than 600 g/m² (85 µm) in the total of the insulators selected as sample and 500 g/m² (70 µm) in each of the individual insulators.</p>

3) Value to be specified by the manufacturer.

4) These values include the lack of dielectric flatness and its ovality.

6.3 Marking

Requirement	Description
R030	<p>The string insulator elements shall be legibly and indelibly marked on the dielectric or on a metal part with the following minimum indications:</p> <ul style="list-style-type: none"> — manufacturer's name or trademark; — year, week and day of manufacture in accordance with ISO 8601 in truncated representation in the form YYWwwD (e.g.: 08W074, for Thursday of the 7th week of 2008)⁵⁾; — reference identifying the model; — indication of the mechanical or electromechanical failing load.

7 TESTS

The characteristics of the string insulator units covered by this specification shall be confirmed by testing in laboratories accredited and recognised for this purpose. Within this framework, the components of the string insulator units shall be subjected to the tests defined in this section and the string insulator units shall be subjected to the individual type tests, sampling tests and series tests defined in sections 7.1 07.3 (a table summarising the tests applicable to the elements of string insulators is given in Annex C).

E-REDES (or its representative) reserves the right to attend any of the tests specified in the following sections.

Requirement	Description
E001	<p>Tests on cap materials</p> <p>The characteristics of cast irons in string unit caps shall be determined according to the applicable standards defined in section 0of this document.</p>
E002	<p>Tests on the materials of the pins</p> <p>The characteristics of steels in string unit pins shall be determined according to the applicable standards defined in section 0of this document.</p>
E003	<p>Dielectric tests of string units</p> <p>The characteristics of ceramic materials and glass for the dielectrics of the string insulator units shall be determined according to IEC 60672-2.</p>
E004	<p>Tests of the polyamide fibre of the flocked ring</p> <p>If the flocked ring is present, the characteristics of the polyamide fibre which comprises it shall be determined according to the applicable standards.</p>
E005	<p>Cement tests</p> <p>The cements used for connecting the caps and pins to the dielectrics shall be tested according to the applicable standards.</p>

5) For this indication, the following two alternatives are allowed:

- indication only of the year of manufacture in accordance with ISO 8601, in reduced precision representation of the date in the form CCYY (e.g.: 2023);

- indication of the year and week of manufacture in accordance with ISO 8601, in truncated representation in the form YYWww (e.g.: 23W08, for the eighth week of 2023).

7.1 Type tests - string insulator units

All type tests shall as a rule be carried out in the order specified.

Full or partial repetition of the type tests may be required if there are doubts about the maintenance of the characteristics of the connectors during the course of supplies or if there are changes in the manufacturing technology or raw materials used. The manufacturer/supplier shall inform E-REDES whenever such a situation arises.

Requirement	Description
E006	Dimension checking In accordance with Table C1 of ANNEX C this document.
E007	Dry lightning impulse withstand voltage (1.2/50 μs) In accordance with Table C1 of ANNEX C this document.
E008	Industrial wet power-frequency withstand voltage (50 Hz) In accordance with Table C1 of ANNEX C this document.
E009	Radio interference voltage (RIV) test In accordance with Table C1 of ANNEX C this document and the following: This test shall be carried out on each string insulator unit individually. The test circuit, equipment and atmospheric conditions shall be in accordance with IEC 60437. The test shall be carried out with a voltage level of 10 kV. It can be carried out with 20 kV, provided this is agreed with the manufacturer/supplier and E-REDES. <u>Acceptance criteria:</u> — $\leq 50 \mu\text{V}$ (34 dB) for a test voltage $\leq 10 \text{ kV AC}$; — $\leq 320 \mu\text{V}$ (50 dB) for a test voltage $\leq 20 \text{ kV AC}$.
E010	Puncture voltage in air behaviour test In accordance with Table C1 of ANNEX C this document.
E011	Electromechanical failing load test In accordance with Table C1 of ANNEX C this document.
E012	Mechanical failing load test In accordance with Table C1 of ANNEX C this document.
E013	Thermomechanical performance test In accordance with Table C1 of ANNEX C this document.
E014	Residual strength test In accordance with Table C1 of ANNEX C this document.

<p>E015</p>	<p>Zinc sleeve test (if applicable)</p> <p>In accordance with Table C1 of ANNEX C this document and the following:</p> <p>The zinc sleeve test shall only be performed on cap and pin string insulator units when these have a zinc sleeve. This sleeve, if any, shall be made of zinc with a purity of 99.8%. The connecting surface of the sleeve shall be at least 80% of the interface between the sleeve and the pin. The exposed unit of the sleeve shall have a mass of at least 5 g. Approximately 50% of the overall sleeve length should be exposed.</p> <p>The manufacturer shall provide the certificate of purity of the zinc used in the sleeve.</p> <p>Each insulator shall be subjected to a tension equal to 65% of the (electro-)mechanical failing load and shall be held with this load for one minute. Then the load shall be removed, the pin disassembled and the sleeve inspected for cracks.</p> <p>The sleeve conforms if after application of the force there are no radial cracks in the sleeve or circumferential cracks in the interface between the sleeve and the pin.</p> <p>The pins are then subjected to tension until rupture occurs. The coupling surface shall be examined and shall not be less than 80% of the interface between the sleeve and the pin (the coupling surface is dull and non-reflective).</p>								
<p>E016</p>	<p>Impact test</p> <p>In the impact test, the string insulator unit shall be placed in the test apparatus shown in ANNEX D , with its metal parts attached to the couplings of the test apparatus under a tensile strength of approximately 9000 N. The height of the axis of rotation of the pendulum shall be adjusted so that, when released, the copper point of the impact body directly touches the outer edge of the flap in a direction parallel to the axis of the insulator. The direction of impact shall be from the pin to the cap. The string insulator unit shall be struck with the specified severity by lifting the impact body until the pointer on the rod of the test apparatus points to the desired value on the scale, and then releasing that impact body in freefall without any external acceleration.</p> <p>The insulator unit must not rupture at lower impact energies than those specified in Table 2 for each insulator model.</p> <p>For ceramic string insulator units, their integrity shall be verified by conducting a 1-minute additional industrial dry power-frequency withstand voltage test (50 Hz).</p> <p>The impact test shall be carried out on insulators with a cap and pin with normal profiles or anti-pollution.</p> <p style="text-align: center;">Table 2 Acceptance criteria for the impact test</p> <table border="1" data-bbox="647 1476 1209 1662"> <thead> <tr> <th>Specified failing load [kN]</th> <th>Impact energy [Nm]</th> </tr> </thead> <tbody> <tr> <td>40 – 70</td> <td>5</td> </tr> <tr> <td>100 - 120</td> <td>6</td> </tr> <tr> <td>≥ 160</td> <td>10</td> </tr> </tbody> </table>	Specified failing load [kN]	Impact energy [Nm]	40 – 70	5	100 - 120	6	≥ 160	10
Specified failing load [kN]	Impact energy [Nm]								
40 – 70	5								
100 - 120	6								
≥ 160	10								

7.2 Factory Acceptance Tests - Sampling tests - string insulator units

Sampling tests shall be carried out in order to verify the characteristics of a given batch of string insulator units that may vary with the manufacturing process and the quality of the materials constituting the string insulator units.

Requirement	Description																							
E017	<p>Sampling rules and procedures</p> <p>In the sampling tests, the sample taken at random from the batch is divided into three groups: E1, E2 and E3. The sample sizes are given in Table 3. Where the total quantity of the batch exceeds 10,000 units, they shall be divided into an ideal quantity of equal batches with quantities of between 2,000 and 10,000. The results of the tests shall be assessed separately for each batch. For $N \leq 300$, the number of samples is defined as zero.</p> <p>The string insulator units shall be selected randomly from the batch. E-REDES (or its representative) shall have the right to select the samples.</p> <p>The samples shall be subjected to the sampling tests defined in this section.</p> <p>Where a sample does not meet the requirements of a test, the provisions of the following shall be applied: E018.</p> <p style="text-align: center;">Table 3 Sampling tests</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th rowspan="2">Batch size (N)</th> <th colspan="3">Sample Size</th> </tr> <tr> <th>E1</th> <th>E2</th> <th>E3</th> </tr> </thead> <tbody> <tr> <td>$N \leq 300$</td> <td colspan="3" style="text-align: center;">0</td> </tr> <tr> <td>$300 < N \leq 2000$</td> <td style="text-align: center;">4</td> <td style="text-align: center;">3</td> <td style="text-align: center;">3</td> </tr> <tr> <td>$2000 < N \leq 5000$</td> <td style="text-align: center;">8</td> <td style="text-align: center;">4</td> <td style="text-align: center;">4</td> </tr> <tr> <td>$5000 < N \leq 10000$</td> <td style="text-align: center;">12</td> <td style="text-align: center;">6</td> <td style="text-align: center;">6</td> </tr> </tbody> </table>	Batch size (N)	Sample Size			E1	E2	E3	$N \leq 300$	0			$300 < N \leq 2000$	4	3	3	$2000 < N \leq 5000$	8	4	4	$5000 < N \leq 10000$	12	6	6
Batch size (N)	Sample Size																							
	E1	E2	E3																					
$N \leq 300$	0																							
$300 < N \leq 2000$	4	3	3																					
$2000 < N \leq 5000$	8	4	4																					
$5000 < N \leq 10000$	12	6	6																					
E018	<p>Acceptance criteria</p> <p>If only one string insulator unit or metal part fails the sampling tests, a new sample of two times the size of the original quantity submitted for the test shall be selected and retested. In addition to the test where the failure occurred, the insulators making up the new sample shall be subjected to the tests that influenced the results of the test where the failure was recorded.</p> <p>If two or more string insulator units or metal parts fail in any of the sampling tests, or if any failure occurs in the repeated test, the batch shall be deemed non-compliant and shall be rejected by the manufacturer.</p> <p>If the cause of the failure can be clearly identified, the manufacturer may select and remove from the batch all units containing the failure (in the case of a batch that has been divided into smaller batches and, in the case of one of the smaller batches not complying, the analysis may be extended to the other batches). The selected batch(es) or part thereof may be re-sampled. In this case the new sample to be selected shall be three times the initial quantity used in the sampling tests. In addition to the test where the failure occurred, the insulators making up the new sample shall be subjected to the tests that influenced the results of the initial test. If any insulator fails during this test, the whole batch shall be deemed non-compliant.</p>																							
E019	<p>Dimension checking</p> <p>In accordance with Table C1 of ANNEX C this document.</p>																							
E020	<p>Displacement checking (axial and radial)</p> <p>In accordance with Table C1 of ANNEX C this document.</p>																							

E021	Interlocking device checking In accordance with Table C1 of ANNEX C this document.
E022	Galvanisation checking In accordance with Table C1 of ANNEX C this document.
E023	Resistance to sudden temperature changes In accordance with Table C1 of ANNEX C this document.
E024	Radio interference voltage (RIV) test In accordance with Table C1 of ANNEX C this document.
E025	Puncture voltage in air behaviour test In accordance with Table C1 of ANNEX C this document.
E026	Electromechanical failing load test In accordance with Table C1 of ANNEX C this document.
E027	Mechanical failing load test In accordance with Table C1 of ANNEX C this document.
E028	Thermal shock test In accordance with Table C1 of ANNEX C this document.
E029	No porosity In accordance with Table C1 of ANNEX C this document.
E030	Zinc sleeve test (if applicable) The pins to be tested may be the pins of the string insulator units which have undergone the mechanical (electro-) failing load test. The exposed zinc mass must be greater than 5 g. The quality of the metallurgical bond should be established by mechanically removing the sleeve from the pin. The sleeves can be removed from the pins by applying the appropriate force to the pin. The coupling surface shall be examined and shall not be less than 80% of the interface between the sleeve and the pin (the coupling area has an opaque and non-reflective surface).

7.3 Individual series tests - string insulator units

Series tests aim to detect and eliminate defective units and are carried out during the manufacturing process on all units.

Requirement	Description
E031	Individual visual inspection In accordance with Table C1 of ANNEX C this document.
E032	Individual mechanical test In accordance with Table C1 of ANNEX C this document.
E033	Individual electrical tests In accordance with Table C1 of ANNEX C this document.

E034	<p>Individual thermal shock test</p> <p>In accordance with Table C1 of ANNEX C this document and the following:</p> <p>The following thermal shocks shall be applied:</p> <p>Cold to hot thermal shock: each dielectric (glass component) shall be brought from room temperature to at least 300 K higher, and this temperature shall be maintained for at least one minute.</p> <p>Hot to cold thermal shock test: each dielectric (glass component) shall be dipped suddenly in water at a temperature of no more than 50 °C and the insulator has been pre-immersed, heated by hot air or other suitable means at a uniform temperature of at least 100 K above the water temperature.</p> <p><u>Acceptance criteria</u></p> <p>All insulators that fracture shall be discarded.</p>
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7.4 Acceptance tests - string insulator elements

The purpose of the acceptance tests is to verify that a given supply of string insulator units has the desired characteristics through a sampling analysis.

Requirement	Description
E035	<p>Acceptance tests</p> <p>The acceptance tests shall consist of the sampling tests defined in Section 0.</p>

8 WRAPPING AND PACKAGING

Requirement	Description
R031	<p>Collective packaging</p> <p>String insulator units shall be provided in wooden boxes/structures with 6 units, which keep them stable and undamaged in outdoor storage conditions.</p>
R032	<p>Barcode and QR code - information</p> <p>The material characteristics should be printed in a QR Code according to the format defined in the E-REDES QR Code generation platform for the class "Insulators".</p> <p>The bar code shall be printed at least on the collective packaging and durability shall be ensured until installation.</p>
R033	<p>Barcode and QR code – location</p> <p>The bar codes and the QR code must be located in such a way that they can be read with the equipment wrapped and packaged.</p>

9 DOCUMENTATION TO BE SUBMITTED IN PROPOSALS

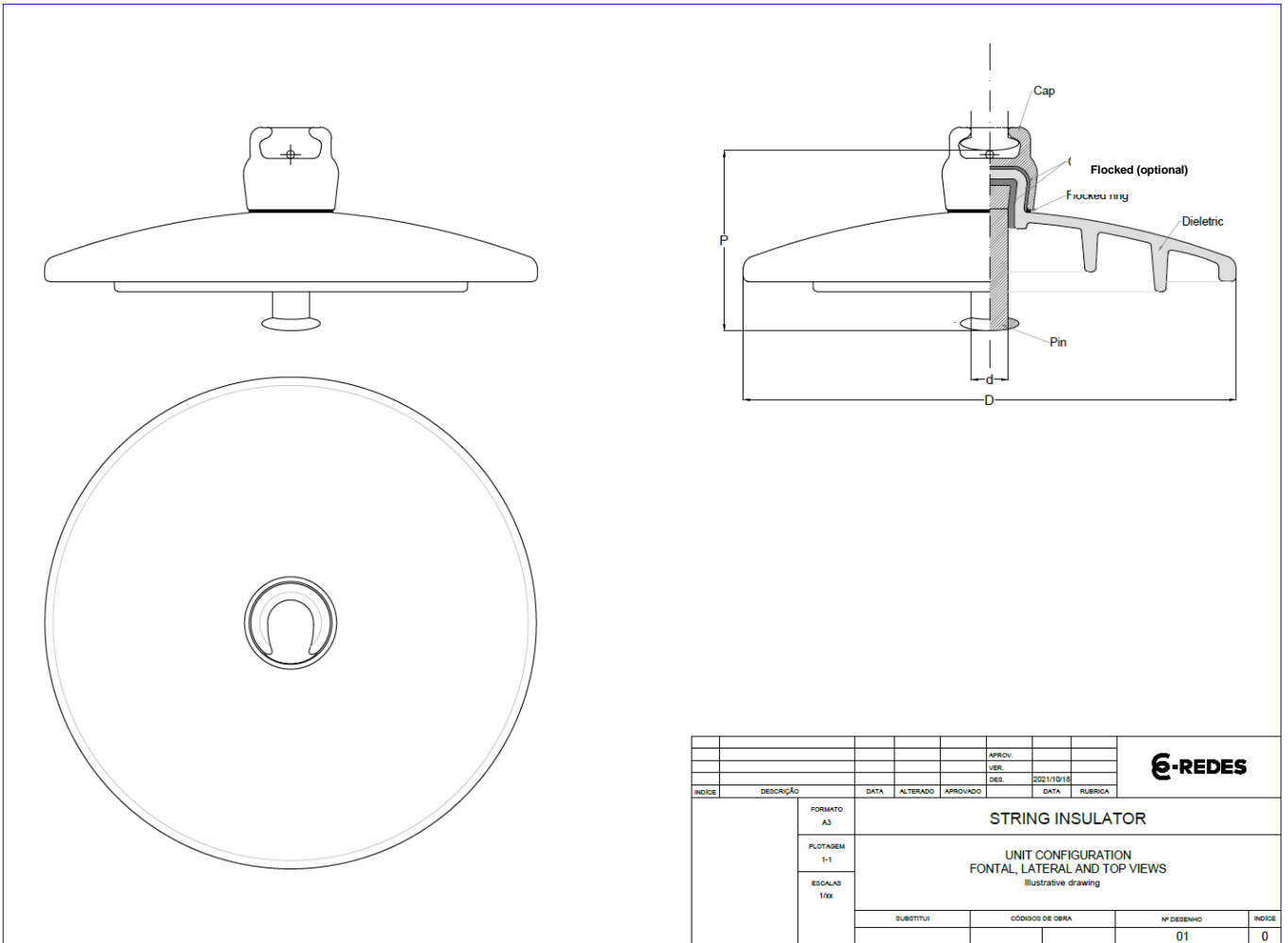
Requirement	Description
R034	<p>Documentation to be submitted in proposals - detailed drawings and catalogues</p> <p>Applicants shall submit the drawings with the geometric parameters of each model and the respective catalogues.</p>

Requirement	Description
R035	<p>Documentation to be submitted in proposals - Table of characteristics - ANNEX E</p> <p>Applicants shall submit all information and documentation demonstrating the compliance of the proposed products with this specification.</p> <p>They must complete (in .xlsx file to be submitted by E-REDES) the characteristics to be supplied and guaranteed by the manufacturer, for each type of string insulator unit (ANNEX E to this document).</p>
R036	<p>Documentation to be submitted in proposals - Test framework - ANNEX F</p> <p>Applicants shall submit all information and documentation demonstrating the compliance of the proposed products with this specification.</p> <p>They shall enter (in an .xlsx file to be submitted by E-REDES) the test results set out in this document for each type of string insulator unit proposed according to the test table in ANNEX FF.</p>
R037	<p>Documentation to be submitted in proposals - sampling and individual series tests</p> <p>Applicants shall demonstrate that the sampling tests and the individual series tests, as defined in sections 0 and 7.3 respectively, are carried out in the manufacturing process of the string insulator units.</p>
R038	<p>During the accreditation process E-REDES reserves the right to examine samples of the equipment.</p>

10 ENVIRONMENT

Requirement	Description
R039	<p>Safety and environmental legislation</p> <p>Products and their constituents must comply with the applicable European technical standards and comply with all applicable legislation in force, specifically the Reach, RoHs, WEE and 2009/125/EU directives.</p>
R040	<p>Safety and environmental legislation – Ecodesign</p> <p>The manufacturer/supplier must guarantee that all the equipment/products supplied and used in the tasks carried out by them or by subcontractors comply with the applicable European technical standards, constitute the best available technologies, respect all eco-design regulations and standards and comply with all applicable legislation in force.</p>
R041	<p>End-of-life treatment</p> <p>The supplier must provide sufficient information so that all components can be broken down or recycled in accordance with international and national legislation.</p>
R042	<p>Use of hazardous substances</p> <p>The products must comply with the provisions on the use and restrictions of certain hazardous substances in electrical and electronic equipment (EEE), labeling and placing on the market, namely those provided for in Decree-Law no. 79/2013, of June 11, rectified by Declaration of Rectification no. 35/2013, of August 5, and amended by Decree-Law no. 119/2014, of August 6, Decree-Law no. 30/2016, of June 24 and Decree-Law no. 61/2017, of June 9. The successful tenderer must provide proof of this legal framework.</p>

ANNEX A
DIMENSIONS AND CONSTITUTION OF STRING INSULATOR UNITS



INDICE	DESCRIÇÃO	DATA	ALTERADO	APROVADO	APROV.	VER.	DES.	DATA	RUBRICA
	FORMATO A3								
	PLOTAGEM 1:1						202/11/9/18		
	ESCALAS 1:1X								
					STRING INSULATOR				
					UNIT CONFIGURATION FONTAL, LATERAL AND TOP VIEWS Illustrative drawing				
	SUBSTITUI								
	CODIGOS DE OBRA								
	Nº DESENHO								
								01	0

ANNEX B
TECHNICAL CHARACTERISTICS OF STRING INSULATOR UNITS

Table B1

Stipulated characteristics of string insulator units

Requirement	String unit reference (IEC 60305) / E-REDES string unit reference	U 70 BS	U 100 BS	U 100 BLP
R008	Maximum nominal diameter of the insulating part, D [mm]	255	255	280
R009	Nominal spacing, P [mm]	127	127	146
R010	Minimum nominal creepage distance, L [mm]	295	295	445
R011	Standard Coupling, d1 [mm] (IEC 60120)	16	16	16
R012	Dimensions of the balls of the pins and sockets of the caps	16A	16A	16A
R013	Shape of safety devices	Clip or W-shaped spring		
R016	Specified electromechanical or mechanical failing load [kN]	70	100	100
R017	Specified industrial wet power-frequency withstand voltage – string unit [kV]	40	40	50
R018	Specified industrial wet power-frequency withstand voltage - short string with 5 units, without rods [kV]	175	175	190
R019	Specified dry lightning impulse withstand voltage – string unit [kV]	100	100	110
R020	Specified dry lightning impulse withstand voltage – short string with 5 units, without rods [kV]	395	395	430
R021	Specified withstand puncture voltage at industrial frequency [kV]	115	115	125
R025	Manoeuvring force for clips – minimum force/maximum force [N]	50/500		
	Manoeuvring force for W-shaped springs – minimum force/maximum force [N]	25/250		

ANNEX C
STRING INSULATOR UNIT TESTS

Table C1

Component tests of string insulator units — cap and pin — class B⁽¹⁾ (ceramic material — toughened glass)

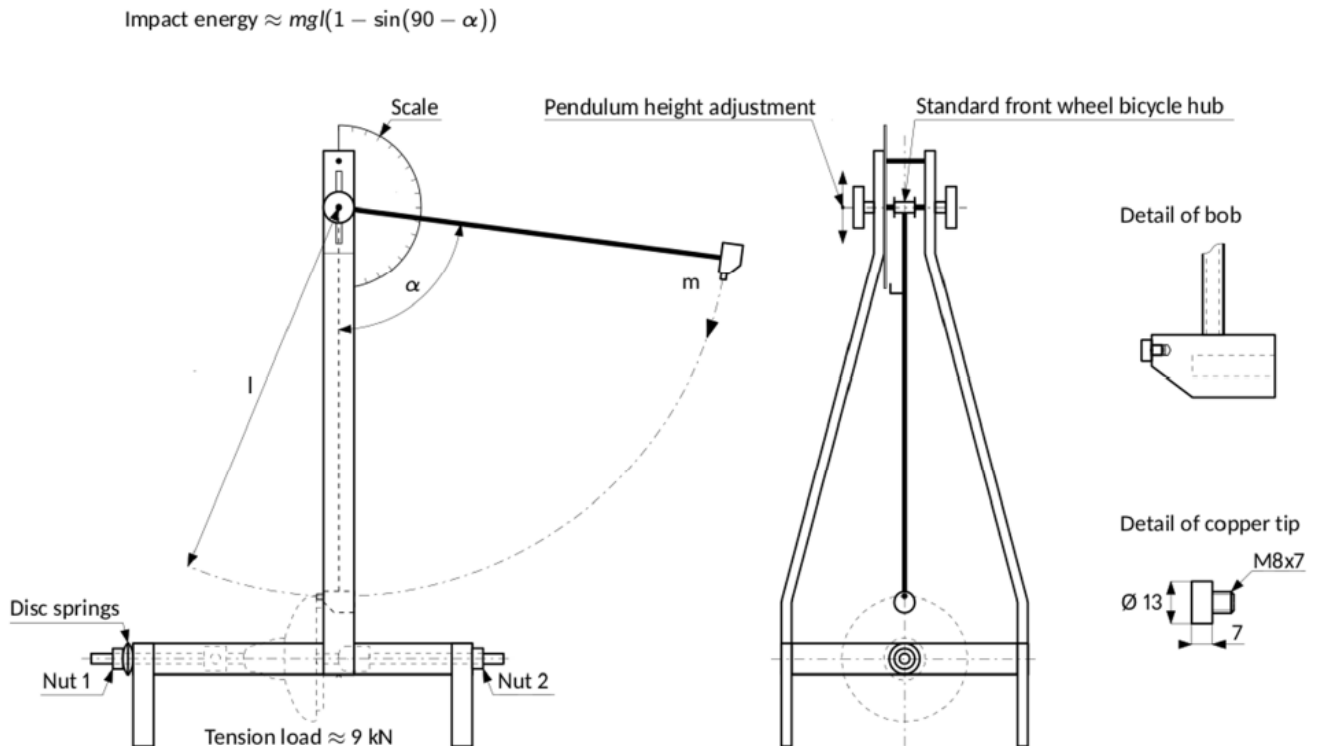
Tests		Ceramic material (quantities of insulators to be tested)	Toughened glass (quantities of insulators to be tested)	Standard section IEC 60383-1	Standards for testing	
Type tests	E006	Dimension checking	10	10	17	IEC 60383-1 IEC 60305 IEC 60120
	E007	Dry lightning impulse withstand voltage (1.2/50 μ s)	1CC ³⁾	1CC ³⁾	13, 34, 35	IEC 60383-1 IEC 60060-1
	E008	Industrial wet power-frequency withstand voltage (50 Hz)	1CC ³⁾	1CC ³⁾	14, 34, 35	IEC 60383-1 IEC 60060-1
	E009	Radio interference voltage (RIV) test	3	3	14	IEC 60383-1
	E010	Puncture voltage in air behaviour test	10	10	---	IEC 61211
	E011	Electromechanical failing load test	5+5 ⁴⁾	N/A	18, 33.1	IEC 60383-1 IEC 60120
	E012	Mechanical failing load test	N/A	5+5 ⁴⁾	19.2, 19.4, 33.1	IEC 60383-1 IEC 60120
	E013	Thermomechanical performance test	10	10	20, 33.1	IEC 60383-1
	E014	Residual strength test	25	25	---	IEC 60797
	E015	Zinc sleeve test (if applicable)	3	3	28	IEC 60383-1
	E016	Impact test	3	3	30	IEC 60383-1
Sample tests	E019	Dimension checking ²⁾	E1 and E2 ⁵⁾	E1 and E2 ⁵⁾	17	IEC 60383-1 IEC 60305 IEC 60120
	E020	Displacement checking (axial and radial)	E1 and E2 ⁵⁾	E1 and E2 ⁵⁾	21	IEC 60383-1 IEC 60120
	E021	Interlocking device checking	E2 ⁵⁾	E2 ⁵⁾	22	IEC 60383-1 IEC 60372
	E022	Galvanisation checking	E2 ⁵⁾	E2 ⁵⁾	26	IEC 60383-1 ISO 1459 ISO 1460 ISO 1461 ISO 1463 ISO 2064 ISO 2178
	E023	Resistance to sudden temperature changes	E1 and E2 ⁵⁾	N/A	23.1	IEC 60383-1
	E024	Radio interference voltage (RIV) test ⁶⁾	E3 ⁵⁾	E3 ⁵⁾	14	IEC 60383-1
	E025	Puncture voltage in air behaviour test ⁷⁾	E3 ⁵⁾	E3 ⁵⁾	15	IEC 60383-1 IEC 61211
	E026	Electromechanical failing load test	E1 ⁵⁾	N/A	18, 33.2	IEC 60383-1 IEC 60120
E027	Mechanical failing load test	N/A	E1 ⁵⁾	19.2, 19.4, 33.2	IEC 60383-1 IEC 60120	

	E028	Thermal shock test	N/A	E2 ⁵⁾	24	IEC 60383-1
	E029	No porosity	E1 ⁵⁾	N/A	25	IEC 60383-1
	E030	Zinc sleeve test (if applicable)	Half of E1 ⁵⁾	Half of E1 ⁵⁾	---	---
Individual tests	E031	Individual visual examination	All	All	27	IEC 60383-1
	E032	Individual mechanical test	All	All	28	IEC 60383-1
	E033	Individual electrical test	All	N/A	16	IEC 60383-1
	E034	Individual thermal shock test	N/A	All	---	---

- 1) An insulator or a string unit is class B if the shortest length of the perforated channel (through the solid insulating material) is less than half the shortest distance in the exterior air to the insulator.
- 2) E1 and E2 for dimensions to which special tolerances apply (example: step (IEC 60305)) and details that may jeopardise interchangeability (IEC 60120); E2 only for other dimensions. See section 17 of IEC 60383-1.
- 3) 1CC = Test to be carried out on a short 5-unit string.
- 4) 5 samples shall be taken from the samples which have been subjected to the puncture voltage in air behaviour test.
- 5) E1, E2 and E3: sample numbers as prescribed in E017.
- 6) Introduced as a sampling test, as it can show variation in quality. This test may be omitted if agreed between the manufacturer and the buyer in case radio interference is not a problem on the ground.
- 7) This test may be replaced by the voltage test at industrial frequency, with the element immersed in the oil, if it is possible to carry out this test (see section 15.1 of IEC 60383-1).

**ANNEX D
IMPACT TEST**

An example of an assembly to perform the impact test is given:



Where:

l – Pendulum length (0.8 to 1 m)

α - angle from which the pendulum is released

m - mass of impact body including the rod (kg)

Mechanical tension can be applied through disk springs or through a hydraulic system.

The total mass to be used in the impact energy calculation formula is the sum of the mass of the body and the mass of the rod that holds it. This total mass can be obtained by placing the impact body at an angle of 90 degrees and weighing the whole set (rod and body).

The impact body can also be assembled in reverse if required due to the type of string insulator unit (e.g. anti-pollution type).

The string insulator units to be tested shall be placed so that the impact occurs only with the copper tip of the impact body, and that the movement of the impactor is vertical to the axis of the element of string insulators.

ANNEX E
CHARACTERISTICS TO BE SUPPLIED AND GUARANTEED BY THE MANUFACTURER

Note: Any non-compliance with the specification must be clearly indicated in this document.

E-REDES Designation: _____

Ref. E-REDES of the string insulator units: _____

Manufacturer reference: _____

Supplier: _____

Manufacturer: _____

Factory location: _____

Requirement	Characteristics	Characteristic/value (declared by the manufacturer)	Assessment (C/NC)	Documentation references (document/page)
R001	Dielectric			
R002	Cap			
R003	Cement			
R004	Flocked			
R005	Pin			
R006	Safety device			
R007	Colour			
R008	Maximum nominal diameter of the insulating part, D			
R009	Nominal step, P			
R010	Minimum nominal creepage, L			
R011	Pin diameter, d1			
R012	Dimensions of the balls of the pins and sockets of the caps			
R013	Shape of safety devices			
R014	Safety device dimensions			
R015	Dimensional tolerances			
R016	Specified electromechanical or mechanical failing load			
R017	Specified industrial wet power-frequency withstand voltage – string unit			

Requirement	Characteristics	Characteristic/value (declared by the manufacturer)	Assessment (C/NC)	Documentation references (document/page)
R018	Specified industrial wet power-frequency withstand voltage - short string with 5 units, without rods			
R019	Specified industrial dry power-frequency withstand voltage – string unit			
R020	Specified industrial dry power-frequency withstand voltage – short string with 5 units, without rods			
R021	Withstand puncture voltage at industrial frequency			
R022	Specified withstand puncture voltage in air			
R023	Thermomechanical performance			
R024	Axial and radial displacements			
R025	Manoeuvring force - Safety devices			
R026	Resistance to sudden temperature changes (only for ceramic material string units)			
R027	Thermal shock resistance (for toughened glass string units only)			
R028	No porosity			
R029	Galvanisation Quality			
R030	Marking			
R031	Collective packaging			
R032	Barcode and QR code - information			
R033	Barcode and QR code – location			
R034	Documentation to be submitted in proposals - detailed drawings and catalogues			
R035	Documentation to be submitted in proposals - Table of characteristics - Annex E			
R036	Documentation to be submitted in proposals - Test framework - Annex F			
R037	Documentation to be submitted in proposals – sampling and individual series tests			

**ANNEX F
TEST TABLE**

E-REDES Designation: _____
 Manufacturer reference: _____
 Supplier: _____
 Manufacturer: _____

Requirement	Tests	Laboratory	Report Reference ¹⁾	Test Result	Observations
E001	Tests on cap materials				
E002	Tests on the materials of the pins				
E003	Dielectric tests of string units				
E004	Tests of the polyamide fibre of the flocked ring				
E005	Cement tests				

Type tests - string insulator units

Requirement	Tests	Laboratory	Report Reference ¹⁾	Test Result	Observations
E006	Dimension checking				
E007	Dry lightning impulse withstand voltage (1.2/50 μ s)				
E008	Industrial wet power-frequency withstand voltage (50 Hz)				
E009	Radio interference voltage (RIV) test				
E010	Puncture voltage in air behaviour test				
E011	Electromechanical failing load test				
E012	Mechanical failing load test				
E013	Thermomechanical performance test				
E014	Residual strength test				
E015	Zinc sleeve test (if applicable)				
E016	Impact test				

Sampling tests — string insulator units					
Requirement	Tests	Laboratory	Report Reference¹⁾	Test Result	Observations
E019	Dimension checking ²⁾				
E020	Displacement checking (axial and radial)				
E021	Interlocking device checking				
E022	Galvanisation checking				
E023	Resistance to sudden temperature changes				
E024	Radio interference voltage (RIV) test ⁶⁾				
E025	Puncture voltage in air behaviour test ⁷⁾				
E026	Electromechanical failing load test				
E027	Mechanical failing load test				
E028	Thermal shock test				
E029	No porosity				
E030	Zinc sleeve test (if applicable)				

1) The manufacturer shall indicate the reference of the test report submitted by which it wishes to demonstrate technical compliance with this DMA-C66-140 in detail (section, page number, etc.).

ANNEX G
SPECIFIED PRODUCT LIST

SAP Code	Short material text
20144253	ISOLADOR CADEIA CAMP ESPIGAO U70BS
20144252	ISOLADOR CADEIA CAMP ESPIGAO U100BS
20144251	ISOLADOR CADEIA CAMP ESPIGAO U100BLP