

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

CONTENTS

1 DOCUMENT AIMS AND APPLICATION AREA	3
1.1 RELATED DOCUMENTS TO BE IMPLEMENTED AT COUNTRY LEVEL	3
2 DOCUMENT VERSION MANAGEMENT	4
3 UNITS IN CHARGE OF THE DOCUMENT	4
4 REFERENCES	4
5 ORGANIZATIONAL process POSITION IN THE PROCESS TAXONOMY	8
6 DEFINITIONS AND ACRONYMS	8
7 DESCRIPTION	9
7.1 List of Components	9
7.1.1..STANDARD ARMoured CABLE $U_0/U(U_{max})= 0,6/1 (1,2)$ kV	9
7.2 Technical characteristics	10
7.2.1..Type of cables	10
7.3 CONSTRUCTION CHARACTERISTICS	12
7.3.1..CONDUCTOR	12
7.3.2..INSULATION	13
7.3.3..Filler	14
7.3.4..Armour	14
7.3.5..Outer Sheath	15
7.4 Ampacity and Short-circuit rating	16
7.5 Marking and designation of the cable	16
7.5.1..Cable designation	16
7.5.2..Marking	16
7.6 conditions of supply	17
7.7 TESTING	19



Technical Specification code: GRI-GRI-MAT-E&C-0016

Version no. 6 dated 09/2022

Subject: Global Infrastructure and Networks – GSCC026 LOW VOLTAGE UNDERGROUND ARMoured CABLES WITH RATED VOLTAGE $U_0/U(U_m)$ 0,6/1,0(1,2) kV.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

7.7.1..Acceptance tests	19
7.7.2..Sampling and acceptance criteria	20
7.7.3..Repetition of acceptance tests carried out in presence of Enel's inspector or designate	21
7.7.4..Sampling and acceptance criteria	21
7.7.5..Type test	22
7.8 TECHNICAL CONFORMITY ASSESSMENT	28
7.9.1 General conditions	28
8 Annexes	29
8.1 Check list 3x240+150	29

THE HEAD GLOBAL OF NETWORK COMPONENTS
Fabrizio Gasbarri



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Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

1. DOCUMENT AIMS AND APPLICATION AREA

The aim of this document is to provide technical requirements for the supply of underground low voltage cables to be used exclusively for the maintenance of existing sections of the distribution networks.

These Global Standard applies to the Distribution Companies of Enel Group listed below:

Country	Distribution Company
Argentina	Edesur
Brazil	Enel Distribuição Rio (RJ) Enel Distribuição Ceará (CE) Enel Distribuição Goiás (GO) Enel Distribuição São Paulo (SP)

Distribution Companies

This standard specifies the construction, dimensions and test requirements that must be accomplished by underground low voltage distribution armoured cables with rated voltage $U_0/U(U_{max})= 0,6/1 (1,2)$ kV used in distribution systems by the utilities mentioned above.

This document shall be implemented and applied to the extent possible within the Enel Grids Business Line of the companies mentioned before and in compliance with any applicable laws, regulations and governance rules, including any stock exchange and unbundling-relevant provisions, which in any case prevail over the provisions contained in this document.

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.

Application Areas

Perimeter: *Global*

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Service Function: -

Business Line: *Infrastructure & Networks*

2. DOCUMENT VERSION MANAGEMENT

Version	Date	Main changes description
00	2022	First emission.

3. UNITS IN CHARGE OF THE DOCUMENT

Responsible for drawing up the document:

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

Responsible for authorizing the document:

- Global Infrastructure and Networks: Head of Network Components unit
- Global Infrastructure and Networks: Head of Quality unit.

4. REFERENCES

- Enel Group Code of Ethics;
- The Enel Group Zero Corruption Tolerance (ZCT) Plan;
- Organizational and management model as per Italian Legislative Decree no. 231/2001 or equivalent documents adopted in the Countries;
- Enel Human Rights Policy;
- Stop Work Policy;
- Enel Global Compliance Program (EGCP);
- Integrated Policy of Quality, Health and Safety, Environment and anti-Bribery;
- ISO 9001:2015 - Quality Management System - Requirements;
- ISO 14001:2015 - Environmental Management System - Requirements and user guide;
- ISO 45001:2018 - Occupational Health and Safety Management System - Requirements and user guide;
- ISO 50001:2018 - Energy management systems - Requirements with guidance for use;
- ISO 37001:2016 - Anti-bribery Management System - Requirements with guidance for use.
- MAT-O&M-NCS-2021-0033-EGIN version 3 “Global Infrastructure and Networks – GSCG002 Technical Conformity Assessment”.
- CNS-O&M-S&L-2021-0032-EGIN “Global Infrastructure and Networks Barcode specification.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

GLOBAL STANDARDS

LAWS

Brazil

- *NR-10 - Segurança em Instalações e Serviços em Eletricidade*

Chile

- *NSEG 5 En.71 Reglamento de Instalaciones Eléctricas de Corrientes Fuertes.*

Colombia

- *RETIE, Reglamento Técnico de Instalaciones Eléctricas.*
- *Código Eléctrico Colombiano, NTC 2050*

Peru

- *Código Nacional de Electricidad – Suministro 2011.*
- *Norma Técnica de Calidad de los servicios eléctricos (NTCSE)*

Romania

- *NTE007/08/00 Normativ pentru proiectare și executarea rețelelor de cabluri electrice*

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.*
- *REAL DECRETO 842/2002, de 2 de agosto, por el que se aprueba el Reglamento Electrotécnico para Baja Tensión e Instrucciones Técnicas Complementarias (R.E.B.T.)*
- *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.*
- *Reglamento (UE) nº 305/2011 del Parlamento Europeo y del Consejo, de 9 de marzo de 2011, por el que se establecen condiciones armonizadas para la comercialización de productos de construcción y se deroga la Directiva 89/106/CEE del Consejo.*

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

EUROPEAN & INTERNATIONAL STANDARDS

- EN13501-6 “Fire classification of construction products and building elements - Part 6: Classification using data from reaction to fire tests on electric cables”.
- EN 50575 “Power, control and communication cables - Cables for general applications in construction works subject to reaction to fire requirements”
- HD 603 “Distribution cables of rated voltage 0,6/1 kV”
- HD 605 “Electric cables - Additional test methods”
- IEC 60228: “Conductors of insulated cables”
- IEC 60410: Sampling plans and procedures for inspection by attributes.
- IEC 60502-1:” Power cables with extruded insulation and their accessories for rated voltages from 1 kV up to 30 kV – Part 1: cables for rated voltages of 1 kV and 3 kV”
- IEC 60332-1-2 “Tests on electric and optical fibre cables under fire conditions Part 1-2: Test for vertical flame propagation for a single insulated wire or cable - Procedure for 1 kW pre-mixed flame”
- IEC 60754-1 “Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content”
- IEC 60754-2 “Test on gases evolved during combustion of materials from cables - Part 2: Determination of acidity (by pH measurement) and conductivity”
- IEC 60811-100 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 100: General”
- IEC 60811-201 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 201: General tests - Measurement of insulation thickness”
- IEC 60811-202 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 202: General tests - Measurement of thickness of non-metallic sheath”
- IEC 60811-203 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 203: General tests - Measurement of overall dimensions”
- IEC 60811-401 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 401: Miscellaneous tests - Thermal ageing methods - Ageing in an air oven”
- IEC 60811-402 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 402: Miscellaneous tests - Water absorption tests”
- IEC 60811-403 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 403: Miscellaneous tests - Ozone resistance tests on cross-linked compounds”

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

- IEC 60811-409 “Electric and optical fibre cables - Test methods for non-metallic materials Part 409: Miscellaneous tests - Loss of mass test for thermoplastic insulations and sheaths”
- IEC 60811-501 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 501: Mechanical tests - Tests for determining the mechanical properties of insulating and sheathing compounds”
- IEC 60811-502 “Electric and optical fibre cables - Test methods for non-metallic materials Part 502: Mechanical tests - Shrinkage test for insulations”
- IEC 60811-503 “Electric and optical fibre cables - Test methods for non-metallic materials Part 503: Mechanical tests - Shrinkage test for sheaths”
- IEC 60811-504 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 504: Mechanical tests - Bending tests at low temperature for insulation and sheaths”
- IEC 60811-505 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 505: Mechanical tests - Elongation at low temperature for insulations and sheaths”
- IEC 60811-506 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 506: Mechanical tests - Impact test at low temperature for insulations and sheaths”
- IEC 60811-507 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 507: Mechanical tests - Hot set test for cross-linked materials”
- IEC 60811-508 “Electric and optical fibre cables - Test methods for non-metallic materials Part 508: Mechanical tests - Pressure test at high temperature for insulation and sheaths”
- IEC 60811-605 “Electric and optical fibre cables - Test methods for non-metallic materials-Part 605: Physical tests - Measurement of carbon black and/or mineral filler in polyethylene compounds”
- IEC 61034-2 “Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements”
- IEC 62230 “Electric cables - Spark-test method”
- ISO 2859-0 “Sampling procedures for inspection by attributes -- Part 0: Introduction to the ISO 2859 attribute sampling system”
- ISO 2859-1 “Sampling procedures for inspection by attributes -- Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection”
- Reglamentación AEA 95101 Versión 2015 Líneas Subterráneas Exteriores de Energía y Telecomunicaciones
- HD 603 S2 “Distribution cables of rated voltage 0,6/1 kV”

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

REPLACED LOCAL STANDARDS

NTE-M-055

DCEE02

5. ORGANIZATIONAL PROCESS POSITION IN THE PROCESS TAXONOMY

Value Chain/Process Area: Engineering and Construction.

Macro Process: Materials management Devices and Components Development

Process: Standard Catalog Management.

6. DEFINITIONS AND ACRONYMS

Acronym and Key words	Description
Acceptable Quality Level (AQL)	The maximum percentage of malfunctions that can be detected during a sample inspection and can still be considered satisfactory
Low Voltage (LV)	Any set of nominal voltage levels exceeding 50 V and up to 1 kV a.c. or 1,5 kV d.c.
Technical Conformity Assessment (TCA)	A “conformity assessment” with respect to “specified requirements” ¹ consists in functional, dimensional, constructional and test characteristics required for a product (or a series of products) and quoted in technical specifications and quality requirements issued by Enel Group distribution companies. This also includes the verification of conformity with respect to local applicable regulation and laws and possession of relevant requested certifications

Table 1

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*
7. DESCRIPTION
7.1 LIST OF COMPONENTS
7.1.1.STANDARD ARMoured CABLE $U_0/U(U_{max})= 0,6/1 (1,2) \text{ kV}$

GS Type Code	Distribution Company	Country Code	Type	Formation	Cross-section	Conductor material	Classification	Minimum Number of Wires of Conductor	Minimum conductor diameter [mm]	Maximum conductor diameter [mm]	Insulation material	Nominal insulation thickness [mm]	Minimum insulation thickness [mm]	Insulation Colour	Neutral Cross Section	Min Number of Wires of Neutral Conductor	Minimum neutral conductor diameter [mm]	Maximum neutral conductor diameter [mm]	Neutral Insulation material	Neutral Nominal insulation thickness [mm]	Neutral Minimum insulation thickness [mm]	Insulation Colour	Armouring Section [mm]	Outer sheath material	Sheath nominal thickness [mm]	Sheath min thickness [mm]	Sheath Colour
GSCC026 /001	BR	330295	I	4X16	16	AL	circular not compacted	6	4,6	5,2	XLPE	0,7	0,53	Black	16	6	4,6	5,2	XLPE	0,7	0,53	Black	0,5	PO	1,6	1,3	Black
GSCC026 /002	AR	0101-0468	I	3X25 + 16	25	AL	circular not compacted	6	5,6	6,5	XLPE	0,9	0,71	green, yellow and red	16	6	4,6	5,2	XLPE	0,7	0,53	Light blue	0,5	PO	1,8	1,5	Black
GSCC026 /003	AR	0101-0386	I	3X35 + 16	35	AL	circular not compacted	6	6,6	7,5	XLPE	0,9	0,71	green, yellow and red	16	6	4,6	5,2	XLPE	0,7	0,53	Light blue	0,5	PO	1,9	1,5	Black
GSCC026 /004	BR	330299	I	4X35	35	AL	circular not compacted	6	6,6	7,5	XLPE	0,9	0,71	Black	35	6	6,6	7,5	XLPE	0,9	0,71	Black	0,5	PO	1,9	1,5	Black
GSCC026 /005	AR	0101-0469	I	3X50 + 1X25	50	AL	circular not compacted	6	7,7	8,6	XLPE	1	0,8	green, yellow and red	25	6	5,6	6,5	XLPE	0,9	0,71	Light blue	0,5	PO	2,0	1,6	Black
GSCC026 /006	BR	330297	I	4X95	95	AL	circular not compacted	15	11	12	XLPE	1,1	0,89	Black	95	15	11	12	XLPE	1,1	0,89	Black	0,5	PO	2,3	1,9	Black
GSCC026 /007	AR	0101-0280	I	3x95 + 1x50	95	AL	Sectorial	15	-	13	XLPE	1,1	0,89	green, yellow and red	50	6	7,7	9,4	XLPE	1	0,8	Light blue	0,5	PO	2,3	2,0	Black
GSCC026 /008	BR	330298	I	4X185	185	AL	circular not compacted	15	15,3	16,8	XLPE	1,6	1,34	Black	185	15	15,3	16,8	XLPE	1,6	1,34	Black	0,5	PO	2,9	2,3	Black
GSCC026 /009	AR	0101-0279	I	3x240+120	240	AL	Sectorial	30	-	20,7	XLPE	1,7	1,43	green, yellow and red	120	15	11,6	14,6	XLPE	1,2	0,98	Light blue	0,5	PO	3,1	2,6	Black
GSCC026 /010	AR	0101-0281	II	4X16	16	CU	circular not compacted	7	4,6	5,2	XLPE	0,7	0,53	green, yellow and red	16	7	4,6	5,2	XLPE	0,7	0,53	Light blue	0,5	PO	1,8	1,5	Black
GSCC026 /011	BR	330296	II	4x120	120	CU	circular not compacted	18	12,3	13,5	XLPE	1,2	0,98	Black	120	18	12,3	13,5	XLPE	1,2	0,98	Black	0,5	PO	2,5	2,0	Black

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

7.2 TECHNICAL CHARACTERISTICS

7.2.1. Type of cables

The typical layout of cable is shown in Figure 1

The different parts of the cables are depicted in section 7.4.

In Table 1 Types of cables specified in this document are briefly depicted.

TYPE	DESCRIPTION
I	Quadripolar cable with aluminum conductor, cross-linked polyethylene insulation (XLPE), armour above the three phases and neutral and polyolefin (PO) outer sheath.
II	Quadripolar cable with copper conductor, cross-linked polyethylene insulation (XLPE), armour above the three phases and neutral and polyolefin (PO) outer sheath.

Table 2

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

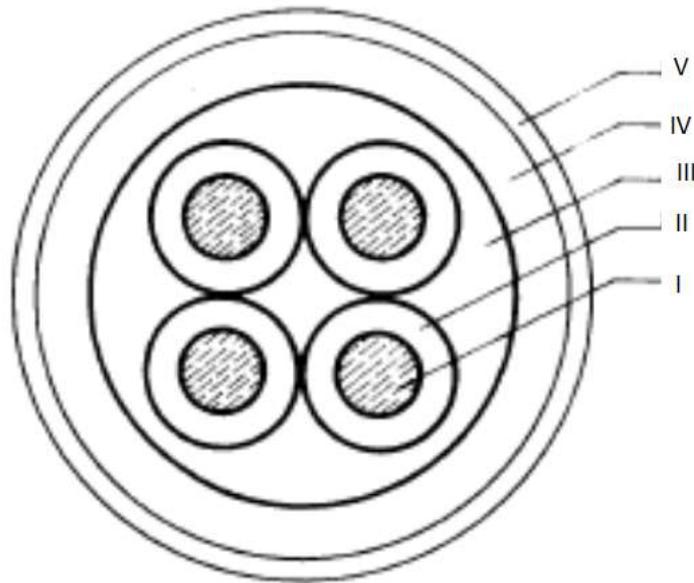


Figure 1 Schematic drawing of cable

I – Conductor

II – Insulation

III -- Filler

IV – Armour

V – Outer Sheath

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

7.3 CONSTRUCTION CHARACTERISTICS

7.3.1.CONDUCTOR

For Type I cables the aluminum conductors shall be stranded compacted circular class 2, complying all the features specified herein and in standard IEC 60228. The conductor material shall be AA-1350 i.e. 99,5% aluminum content.

In Table 2 aluminum conductors main features are depicted.

Nominal cross-section [mm ²]	Minimum number of wires	Diameter of conductors		Maximum resistance of conductor at 20°C [Ω/km]
		[mm]		
		Minimum	Maximum	
16	6	4,6	5,2	1,91
25	6	5,6	6,5	1,2
35	6	6,6	7,5	0,868
50	6	7,7	8,6	0,641
95	15	11	12	0,32
120	15	11,6	12,4	0,253
185	15	15.6	16.8	0,164
240	30	17.6	19.2	0,125

Table 3 Aluminum conductors characteristics according to IEC 60228.

For Type II cables the copper conductors shall be stranded compacted circular class 2, complying all the features specified herein and in standard IEC 60228.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

Copper purity shall not be less than 99,9 %.

In Table 2 copper conductors main features are depicted.

Nominal cross-section [mm ²]	Minimum number of wires	Diameter of conductors		Maximum resistance of conductor at 20°C [Ω/km]
		[mm]		
		Minimum	Maximum	
16	7	4.6	5.2	1,15
120	18	12.3	13.5	0,153

Table 4 Copper conductors characteristics according to IEC 60228.

7.3.2.INSULATION

The insulation shall be applied by a suitable extrusion process and shall form a compact and homogenous body. In addition, it shall be possible to remove without creating any damage to the conductor.

The insulating material shall be cross-linked polyethylene (XLPE) compliant with the characteristics required herein.

The XLPE insulation must allow maximum conductor temperatures of 90 °C in normal operation and 250 °C under short circuit condition by at least 5 seconds.

The minimum thickness of insulation measured and accepted at any point of the cable shall not be less than 90% of the nominal value minus 0,1 mm. In addition, the average of all these measures should not be less than the nominal thickness.

$$t_{min} \geq 0,9 t_n - 0,1$$

Where:

t_{min} : minimum insulation thickness in millimeters

t_n : nominal thickness in millimeters

In Table 3 nominal and minimum thickness for XLPE insulated cables are shown.:

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

Cross-section [mm ²]	Insulation nominal thickness [mm]	Insulation minimum thickness [mm]
16	0,7	0,53
25	0,9	0,71
35	0,9	0,71
50	1	0,80
95	1,1	0,89
120	1.2	0.98
185	1,6	1,34
240	1.7	1.43

Table 5 Insulation thickness
7.3.3. Filler
7.3.3.1. Central Fillers

It shall consist of non-hygroscopic textile yarn or by a combination of an extruded compound based on non-vulcanized elastomeric material with textile yarn and that not contaminating insulation and easy to be removed from the cores. The central filler is mandatory for conductor cross-section greater than 25 mm² and optional for the other.

7.3.3.2. Overall Fillers

It shall consist of an extruded compound based on non-vulcanized elastomeric material non -hygroscopic and that not contaminating insulation and easy to be removed from the cores. It shall be penetrate between the cores and must allow easy separation of the concentric conductor wires and cover the laid up cores without gaps. It could be replaced by the inner covering

7.3.3.3. Inner covering

Over the cores assembly shall be applied an inner covering consisting of a cylindrical layer of extruded compound. It shall be based on a non-vulcanized non-hygroscopic elastomeric material and may be extruded or lapped. Optionally, a synthetic tape may be applied helically over the laid up of cores

7.3.4.Armour

The armour is composed by a galvanized steel foil applied over the external filler layer, forming a longitudinal pipe with overlapping glued edges at least of 5 mm.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

7.3.5.Outer Sheath

The outer sheath shall be resistant to moisture, abrasion and UV. In addition, it shall be free from heavy metals or volatile hydrocarbons.

The outer sheath material shall be polyolefin compliant with the characteristics required herein.

The outer sheath shall be adhered to the insulation.

The nominal outer sheath thickness is given by:

$$T_{nom} = 0,035xD + 1$$

Where:

D: diameter under the outer Sheath

The minimum thickness of the outer sheath measured and accepted at any point of the cable shall not be less than 85% of the nominal value minus 0,1 mm. In addition, the average of all these measures should not be less than the nominal thickness.

$$t_{min} \geq 0,85 t_n - 0,1$$

Where:

t_{min} : minimum thickness in millimeters

t_n : nominal thickness in millimeters

In Table 4 nominal and minimum thickness of the polyolefin outer sheath of Type I and Type II cables are shown.

Cross-section [mm ²]	Sheath nominal thickness [mm]	Sheath minimum thickness [mm]
16	1.6	1.3
25	1.8	1.4
35	1.9	1.5
50	2	1.6
95	2.3	1.9
120	2.5	2
185	3.1	2.5

Table 6 PO outer sheath thickness

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

7.4 AMPACITY AND SHORT-CIRCUIT RATING

The ampacity estimated values shall be given for network design purposes.

Such currents shall be calculated in steady state condition, for single core laying and four-core visible helix laying, when installed in open air, directly buried and buried in duct using the following operational conditions:

- Maximum conductor temperature 90 °C
- Ambient air temperature 40 °C
- Ground temperature 20 °C
- Depth of laying 0,8 m
- Soil thermal resistivity 1,5 K m/W

7.5 MARKING AND DESIGNATION OF THE CABLE

7.5.1. Cable designation

The cable designation shall be the following:

- Stranded compacted circular (class 2) aluminum conductor : Al
- Copper conductor WIRES Stranded compacted circular : Cu
- Cross-linked polyethylene insulation: XLPE
- Polyolefin sheath: PO
- Cable formation
- Assigned voltage of the cable expressed in kV: U_0/U
- Armour : AR

7.5.2. Marking

The marking must be indelible paint, easily legible and carried out by engraving or in relief above the surface of the outer sheath in a continuous way.

The distance between the end of the mark and the beginning of the next identical mark does not exceed 550 mm.

The cable marking shall contain:

- Property name: ENEL
- Cable designation: see 7.7.1

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

- Manufacturer name or trademark: XXXXX
- Identification of the production plant with a different letter of the alphabet: B
- Year and month of manufacturing (2022 12):
- Metric marking

Marking Example :

ENEL AI XLPE PO 3x25+16 0,6/1 (1,2) kV AR XXXX B 01 2017 12 0000

7.6 CONDITIONS OF SUPPLY

The conductor will be delivered by the manufacturer in wood or metal drum, which will not be returned, according to maximum and minimum dimensions shown in Table A and according to Figure N° 3.

The total length of the driver given on each reel may not be less than requested in the purchase order and shall not exceed by more than $\pm 5\%$. The maximum gross weight of the reel is packed 2,200 kg.

It should protect the ends of each cable reel with caps to prevent moisture ingress and must be internally secured to the spool ends, and must be mechanically protected against possible damages from the handling and transport of each reel, leaving both accessible through the use of internal helix or conch in each reel ends.

When the distance between the source of manufacture and storage location of the purchaser involving only a means of transport and less than 200 km away, the use of internal propeller only reels of conductors greater than or equal to 120 mm² section is required; this restriction does not release moisture protection of both

The wooden reels spools will be treated according to international requirements for pest control, avoiding the compound "Pentachlorophenol" and "Creosote". Treatment should include, at least: high toxicity to decay organisms, high penetration and holding power, chemical stability, non-corrosive to metals and substances affecting physical characteristics of the wood and weather protection

Note: The purchase order could specify a maximum length of cable in drum.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

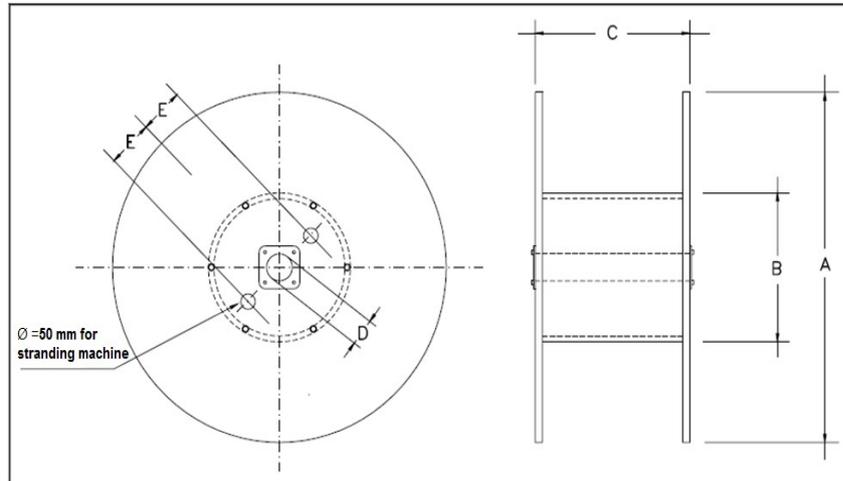


Figure 2

A ⁽¹⁾ mm	B mm	C ⁽¹⁾ mm	D ⁽²⁾ mm	E mm
1730	(3)	1120	80	(4)

Table 7

Notes:

(1) Maximum value.

(2) Minimum value

(3) B shall be the double of the minimum cable curvature radius for transportation, in accordance with Manufacturer specifications.

(4) E shall be 300 or 180 mm, in accordance with the type of spool (large or small, respectively) visible ends of the conductor, mechanical protection and careful handling of the reels.

All spools must:

- 1) Be protected by wooden staves on the exterior, which are to be secured to the wooden spools. An equivalent system is to be used on the metal spools. The staves shall be fastened by steel or plastic bands.
- 2) Show the correct direction for unwinding the spools, by means of an arrow located on the sides.
- 3) Have a rustproof nameplate on each side of the spool. Each nameplate will show the following information (as a minimum), in the language of the country where the cable is to be used (Spanish in Argentina or Portuguese in Brazil).

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

The following data will be required:

- Name of the Manufacturer
- Country of origin of the batch
- The words: "ENEL GROUP"
- Purchase Order number
- Maximum voltage between lines
- Conductor Material and insulation type
- Nominal cross-sectional area (mm²)
- Number of the spool within the batch
- Net weight and gross weight, in kg.
- Length of the conductor, in meters.

Brazil

Reels must meet the requirements of the ABNT NBR 11137 (Reels), ABNT NBR 15126 (Performance requirements) and ABNT NBR 6236 (wood for reel) standard

Argentina

Reels must meet the requirements of the IRAM 9590-1 standard

7.7 TESTING

7.7.1. Acceptance tests

Acceptance tests shall be carried out in the Supplier's facilities and are divided into two types with different sampling criteria, routine test and sample test.

7.8.1.1 Routine tests

Routine tests shall be performed at 100% of delivered spools

The Routine tests are those indicated in par.7.8.5.1 - clause 1, 2, 22.

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

7.8.1.2 Sample test

Sample tests are carried out over samples taken from a complete cable (See **Table x** in sub-clause 7.8.1.3 for sampling).

The Sample tests are those indicated in par.7.8.5.1 - clause 3, 4, 6.

7.7.2.Sampling and acceptance criteria

Quantities always refer to the number of reels.

The supplier shall perform the sampling tests following a single sampling plan for normal inspection, AQL=1,5%, Level I in compliance with standard ISO 2859-1, as long as the resulting minimum number of samples (8) does not exceed 25% of the total lot size. In such case, the number of samples shall be 25% (1/4) of the total lot size rounded down to the nearest unit as shown in the following table.

Amount of Reels	Number of Samples	Acceptable Level	Rejection Level
1 - 32	Amount of reels /4*	0	1
33 - 280	8	0	1
281 - 1.200	32	1	2
1.201 - 3.200	50	2	3
3.201 - 10.000	80	3	4
10.001 - 35.000	125	5	6

Table 8 Application of single sampling plan for normal inspection, AQL=1,5%, Level I in compliance with standard ISO 2859-1

*down to the nearest unit.

The costs of rejected materials will be charged to the bidder. The approval or rejection of each one of the samples will be according to what is required in standard ISO 2859-1 for each one of the trials. In detail, if a lot doesn't comply with what is required in the electric resistance test according to the approval requirements of the reference standard, the Inspector can carry out such test to all the units that make up the lot. If only a single spool is purchased, it must be tested according to what is indicated for a single sample.

Tests performed during the production process on semi-finished products may also be considered valid, as acceptance test, if:

Application AreasPerimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

- The tests are performed as required by the relevant technical specifications and technical standards.
- The sampling plans adopted by the Supplier are in compliance with the aforementioned ones.
- The performed test results are properly recorded.
- The supplier demonstrates that the components/materials features do not vary during further production phases after the test.

The reports of the acceptance tests performed by the supplier shall be prepared and retained, for a possible verification by Enel inspectors.

7.7.3.Repetition of acceptance tests carried out in presence of Enel's inspector or designate

The supplier shall be available to repeat the tests in the presence of Enel's inspector or designate, on a "reduced" sample of the supply lot

7.7.3.1. Routine tests

Routine tests must be performed on a reduced sample by applying the following reduction criteria:

The minimum between:

- 1/3 of Required Sampling (100%)
- Result of Single sampling plans for Normal Inspection, Level I, AQL 1% - according to ISO 2859-1 Ed 5-2007 (See Table 8 in sub-clause 7.8.2 for sampling)

The Routine tests are those indicated in par.7.8.5.1 - clause 1,22 (spark test is not applicable).

7.7.3.2. Sample tests

Sample tests shall be performed at 1/2 of Required Simple size already adopted for the sample test independently performed by the supplier (referring to each test).

The Sample tests are those indicated in par.7.8.5.1 - clause 3, 4, 6

7.7.4.Sampling and acceptance criteria

- Quantities always refer to the number of reels

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

- Enel inspector can choose to perform the test on spools already tested by the Supplier or on others from the lot)
- In case of repetition of routine test attended by Enel Inspector, the spark test is not applicable.
- If only a single spool is purchased, it shall be tested according to what is indicated for a single sample
- On a spool among those subjected to the electrical resistance measurement, shall be performed the verification of the total length of the cable, that shall be not shorter than that declared by the supplier by more than 0,5 m.

Amount of Reels	Number of Samples	Acceptable Level**	Rejection Level**
1 - 41	Amount of reels /3*	0	1
42 - 500	13	0	1
501 – 3200	50	1	2
3.201 – 10.000	80	2	3
10.001 - 35.000	125	3	4

Table 9– Application of single sampling plan for normal inspection, AQL=1%, Level I in compliance with standard ISO 2859-1

*down to the nearest unit.

**The negative result of a single test will result in the rejection of the lot or, when possible, in the repetition of the test on all the units, in order to accept only the compliant ones.

7.7.5.Type test

Type tests shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory performance characteristics to meet the intended application.

When type tests have been successfully performed on one type of cable covered herein with a specific cross-section and construction characteristics, the type's approval shall be accepted as valid for as long as the following conditions are met:

The conductor cross-section is not larger than that of the tested cable.



Technical Specification code: GRI-GRI-MAT-E&C-0016

Version no. 6 dated 09/2022

Subject: Global Infrastructure and Networks – GSCC026 LOW VOLTAGE UNDERGROUND ARMoured CABLES WITH RATED VOLTAGE $U_0/U(U_m)$ 0,6/1,0(1,2) kV.

Application Areas

Perimeter: *Global*

Staff Function: -

Service Function: -

Business Line: *Infrastructure & Networks*

The cable as similar constructions as that of the tested cable, i.e., utilizes same materials, (conductor, insulation, outer sheath) and the same manufacturing process.

When the design, materials or manufacturing process are changed (which might affect the performance characteristics of the cable), the relevant type tests shall be repeated.

Cables shall undergo type tests and acceptance tests for type approval.

For Brazil, for metal screen, tests should also be carried out in accordance with UL 1559, as follows:

- Frame tightness (section 1),
- Elongation (section 18) for cables with frames consisting of a formed and interlocked strip.

formed and interlocked strand.

- Impact (section 19).

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

 7.7.5.1. *Tests list for Type I and Type II cables*

N°	Test	Requirements	Test Method	R	S	T
1	Conductor electrical resistance	See clause 5	IEC 60502-1 sub-clause 15.2	X	-	-
2	Spark test during manufacturing	No breakdown	IEC 62230	X	-	-
3	Conformity to the approved type	See clause 5	Constructional characteristics, markings colors, and phase identification shall be inspected by visual examination. Dimensions, thickness, pitches and diameters shall be measured according to IEC 60811 parts 201, 202 and 203.	-	X	-
4	Verification of the length declared by the supplier	On one of the cable sizes on which the conductor electrical resistances is verified, it must be checked, by measurement, that the finished cable length is not shorter than that declared by the Supplier by more than 0,5 m. In the case the verification result is negative, it must be continued on other sizes to execute a statistical control for attributes on sample as described in the ISO 2859/93 standard, adopting the simple sampling plan, ordinary inspection and acceptable quality level 2,5%, general inspection I		-	X	-
5	Insulation Mechanical properties Before ageing on sample Minimum tensile strength Minimum elongation at break	12,5 MPa 200%	IEC 60811-501	-	-	X
6	Insulation Hot set test Temperature Duration Mechanical stress Maximum elongation under load Maximum residual elongation	200 °C 15 min 0,2 MPa 175% 15%	IEC 60811-507	-	X	-
7	Insulation mechanical properties After ageing on sample Temperature Duration T1 <i>Minimum Tensile strength</i> Maximum variation T1/T0 <i>Minimum elongation at break</i> Maximum variation T1/T0	135 °C 168 h ±25% ±25%	IEC 60811-501 IEC 60811-401	-	-	X

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

N°	Test	Requirements	Test Method	R	S	T
8	Insulation resistance at 90 °C Volume resistivity [$\Omega \cdot \text{cm}$] Insulation constant K_i [$M\Omega \cdot \text{km}$]	10 ¹² 3,67	IEC 60502-1 sub-clause 17.2	-	-	X
9	Insulation Water absorption test (Gravimetric method) Temperature Duration Maximum variation of mass For density $\leq 1,02$ g/ml For density $> 1,02$ g/ml	85 °C 336 h 1 mg/cm ² 5 mg/cm ²	IEC 60811-402	-	-	X
10	Insulation Shrinkage test Duration Temperature Maximum shrinkage	1 h 130 °C 4%	IEC 60811-502	-	-	X
11	PO Mechanical properties Before ageing on sample Minimum tensile strength Minimum elongation at break	12,5 MPa 300%	IEC 60811-501	-	-	X
12	PO mechanical properties After ageing on sample Temperature Duration Minimum Tensile strength Maximum variation T1/T0 Minimum elongation at break Maximum variation T1/T0	110 \pm 2 °C 168 h \pm 25% \pm 25%	IEC 60811-501 IEC 60811-401	-	-	X
13	PO pressure test at high temperature Duration Temperature Coefficient k Maximum depth of indentation	6 h 105 \pm 2 °C 0,6/0,7 50%	IEC 60811-508	-	-	X
14	PO tear resistance test Temperature Minimum resistance	20 \pm 5 °C 9 N/mm	HD 605 Sub clause 2.2.2.2	-	-	X

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

N°	Test	Requirements	Test Method	R	S	T
15	PO test at low temperature When cable $D > 12,5$ mm Elongation test Temperature Minimum elongation When cable $D \leq 12,5$ mm Bending test Temperature	 -15±2°C 20% -15±2°C	 IEC 60811-505 IEC 60811-504	-	-	X
16	PO loss of mass test Temperature Duration Maximum loss of mass	 100±2 °C 168 h 0,5 mg/cm ²	 IEC 60811-409	-	-	X
17	PO Water absorption test (Gravimetric method) Temperature Duration Maximum variation of mass	 85±2 °C 336 h 5 mg/cm ²	 IEC 60811-402	-	-	X
18	PO Heavy metals content test Lead	<0,5%	Spectrophotometer	-	-	X
19	PO UV ray resistance test Tensile strength max variation Elongation at break max variation Decoloration	 15% 15% Low	 HD 605 Sub clause 2.4.23 UNE 211605 for Endesa See Local section B for conditions	-	-	X
20	PO halogen acid gas content	≤ 5 mg/g	IEC 60754-1	-	-	X
21	PO gas acidity and conductivity Minimum pH Maximum conductivity	 4.3 10 μS/mm,	 IEC 60754-2	-	-	X

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

N°	Test	Requirements	Test Method	R	S	T
22	Voltage Test (Manufacturing length)					
	Test voltage	3,5 kV AC or 8,5 kV DC	IEC 60502-1 sub-clause 15.3.2	x	-	-
	Test duration	5 min				
	Test Result	No breakdown				
23	Voltage Test for 4 h (Complete cable)					
	Test voltage	2,4 kV	IEC 60502-1 sub-clause 17.3	-	-	X
	Test duration	4 h				
	Test Result	No breakdown				
24	Cold impact test (Complete cable)					
	Temperature	-15±2 °C	IEC 60811-506	-	-	X
	Test Result	No cracks				
25	Non contamination test (Complete cable)					
	PO Mechanical properties		IEC 60811-501 IEC 60811-401	-	-	X
	Temperature	110±2 °C				
	Duration T1	168 h				
<i>Minimum elongation at break</i>						
	Maximum variation T1/T0	±25%				
26	Shrinkage test (Complete cable)					
	L	200 mm	IEC 60811-503	-	-	X
	Duration	5 x 5 h				
	Temperature	80±2 °C				
	Maximum shrinkage	4%				
27	Special bending test (Complete cable)	No breakdown	HD 605 2.4.1.2	-	-	X
28	Abrasion resistance test (Complete cable)					
	Temperature	20±5 °C	HD 605 Sub-clause 2.4.22	-	-	X
	Mass (cross-section ≤120 mm ²)	12 kg				
	Mass (cross-section ≥150 mm ²)	18 kg				
	Speed	0,3±15% m/s				
	Number of scratches	8				

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

N°	Test	Requirements	Test Method	R	S	T
30	Measurement of smoke density (Complete cable) Minimum light transmittance	60%	IEC 61034-2	-	-	X
R: Routine test S: Sample test T: Type test						

7.8 TECHNICAL CONFORMITY ASSESSMENT

7.9.1 General conditions

The manufacturer shall provide personnel and equipment necessary to carry out type tests and acceptance tests described herein. Otherwise, the supplier could hire the service to a laboratory previously accepted by the customer and assume the cost. The product shall comply with the requirements of GSCG002 regarding the Technical Conformity Assessment.

The equipment should be properly calibrated by a laboratory certified or approved by the client. The manufacturer shall possess up to date calibration certificates (to turn over) at the time of inspection.

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

8. ANNEXES

8.1 CHECK LIST 3X240+150

Item	Description	Unit	Required
1	GENERAL INFORMATION		
1.1	Supplier	-	
1.2	CUI		
1.3	Qualified for FECA03		YES
1.4	Factory Address	-	Qualified Factory Address
2	MAIN FEATURES		
2.1	Global Standard		
2.3	Type Code		
2.4	Nominal Voltage $U_0/U(U_{max})$	[kV]	0,6/1,0 (1,2) kV
2.5	Type I, Type II, Type III or Type IV	-	Type I
2.6	Disposition	[n x mm ²]	3x240+120
3	CONDUCTOR		
3.1	Material	-	ALLUMINIUM (99,5%)
3.2	Nominal cross-section	[mm ²]	240
3.3	Minimum number of wires of conductor	-	30
3.4	Minimum diameter	[mm]	17,6
3.5	Maximum diameter	[mm]	19,2
3.6	Maximum resistance of conductor at 20°C	[Ω/ km]	0,125
3.7	Stranding Type	-	Compacted circular class 2

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

Item	Description	Unit	Required
4	INSULATION		
4.1	Material		XLPE
4.2	Nominal thickness	[mm]	1,7
4.3	Minimum thickness	[mm]	1,43
4.4	Color	-	
4.5	Minimum tensile strength Before ageing	Mpa	12,5
4.6	Minimum tensile strength After ageing	%	±25%
4.7	Insulation Hot Set (135 °C - 15 min - 0,2 MPa)		
a)	Maximum elongation under load	%	175%
b)	Maximum residual elongation	%	15%
4.9	Insulation resistance at 90 °C		
	Volume resistivity	[Ω·km]	10 ¹²
4.8	Shrinkage test (1 h- 130°C)		
	Maximum shrinkage		4%
5	NEUTRAL CONDUCTOR		
5.1	Material	-	ALLUMINIUM (99,5%)
5.2	Nominal cross-section	[mm ²]	120
5.3	Minimum number of wires of conductor	-	18
5.4	Minimum diameter	[mm]	12.3
5.5	Maximum diameter	[mm]	13.5
5.6	Maximum resistance of conductor at 20°C	[Ω/ km]	0,253
5.7	Stranding Type	-	Compacted circular class 2

Application Areas

 Perimeter: *Global*

Staff Function: -

Service Function: -

 Business Line: *Infrastructure & Networks*

Item	Description	Unit	Required
6	NEUTRAL INSULATION		
6.1	Material	-	XLPE
6.2	Nominal thickness	[mm]	1,2
6.3	Minimum thickness	[mm]	0,98
6.4	Color	-	
6.5	Minimum tensile strength Before ageing	Mpa	12,5
6.6	Minimum tensile strength After ageing	%	±25%
6.7	Insulation Hot Set (135 °C - 15 min - 0,2 MPa)		
a)	Maximum elongation under load	%	175%
b)	Maximum residual elongation	%	15%
6.9	Insulation resistance at 90 °C		
	Volume resistivity	[Ω·km]	10 ¹²
6.8	Shrinkage test (1 h- 130°C)		
	Maximum shrinkage		4%
7	ARMOUR		
7.1	Material		Two galvanized steel foil
7.2	Thickness		0.5
8	OUTER SHEATH		
8.1	Material		PO
8.2	Nominal thickness	[mm]	
8.3	Minimum thickness	[mm]	
8.4	Color		Black
8.5	Minimum tensile strength Before ageing	Mpa	12,5
8.6	Minimum tensile strength After ageing	%	±25%
8.7	PO Heavy metals content	%	<0,5%
8.8	PO halogen acid gas content	mg/g	≤ 5
8.9	PO gas acidity and conductivity		
a)	Minimum pH	-	4,3
b)	Maximum conductivity	μS/mm	10
8.10	Shrinkage test (200 mm- 5 x5h- 80±2 °C)		
a)	Maximum shrinkage	%	4%