UNDERGROUND HIGH VOLTAGE CABLES

Countries I&N	
Argentina	**C. Espinoza**
Brazil	**R. Alves**
Brazil	**Ch. de Capdeville**
Chile	**D. Gonzalez**
Colombia	**J. C. Gomez**
Italy	**L. Giansante**
Peru	**R. Sanchez**
Romania	**V. Obrejan**
Spain	**J. Gonzalez**

	Elaborated by	Verified by	Approved by
Global I&N – O&M/NCS	**J.M. Lopez Villena**	**R. Emma**	**M. Mazzotti**

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1 SCOPE

The aim of this document is to provide technical requirements for the supply of HV cables to be used in the distribution networks of Enel Group Distribution Companies, listed below:

Codensa	*Colombia*
Enel Distribución Perú	*Perú*
Edesur	*Argentina*
e-distributie Banat	*Romania*
e-distributie Dobrogea	*Romania*
e-distributie Muntenia	*Romania*
e-distribuzione	*Italy*
Endesa Distribución Eléctrica	*Spain*
Enel Distribución Chile	*Chile*
Enel Electropaulo	*Brazil*
Enel Distribuição Ceará	*Brazil*
Enel Distribuição Rio	*Brazil*
Enel Distribuição Goiás	*Brazil*

This standard specifies the construction, dimensions and test requirements that must be accomplished by high voltage cables with rated voltage above 36 kV and in detail Uo/U (Umax) = 26/45(52) kV, 36/69(72,5) kV, 80/138 (145), 87/150 (170),127/220 (245) kV to be used in distribution systems by the utilities mentioned above.

This standard replaces all the local standards used up to now by all the Distribution Companies, as long as local regulation allows it.

2 LIST OF COMPONENTS

The list of components with the main requirements, which is an integral part of the present document, is reported in the common list attached.

3 REFERENCE LAWS AND STANDARDS

The list of reference laws and standards are mentioned below in this document.

3.1 Laws and Enel Policy

Laws: See Local Sections.

Policy n. 332 Global Infrastructure and Networks Design and construction HV lines guidelines

3.2 European & International Standards

- HD 632 “Power cables with extruded insulation and their accessories for rated voltages above 36 kV (Um = 42 kV) up to 150 kV (Um = 170 kV)”
- IEC 60840 “Power cables with extruded insulation and their accessories for rated voltages above 30kV (Um=36kV) up to 150kV (Um=170kV) test method and requirements”
- IEC 62067 “Power cables with extruded insulation and their accessories for rated voltages above 150 kV (Um=170 kV) up to 500 kV (Um=550 kV) - Test methods and requirements”
- IEC 60228 “Conductor for insulated cable”
- IEC 60229. “Electric cables. Tests on extruded oversheaths with a special protective function.
- 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 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 60811-501 “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 tests for insulations”.
- IEC 60811-503: “Electric and optical fibre cables - Test methods for non-metallic materials - Part 503: Mechanical tests – Shrinkage tests for 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 60885-3: “Electrical test methods for electric cables - Part 3: Test methods for partial discharge measurements on lengths of extruded power cables”
- EN 13501-6 “Fire classification of construction products and building elements - Part 6: Classification using data from reaction to fire tests on electric cables”.
- HD 605 S2 “Electric cables - Additional test methods”.
- IEC 60230 “Impulse tests on cables and their accessories”.
- IEC 60794-1-21 – “Optical fibre cables - Part 1-21: Generic specification - Basic optical cable test procedures - Mechanical tests methods”
- IEC TR 61901:2016 “Tests recommended on cables with a longitudinally applied metal foil for rated voltages above 30 kV (Um = 36 kV) up to and including 500 kV (Um = 550 kV)”

3.3 Local Standards

See Local Section.

3.4 Replaced Local Standards

DC4597, DKEE01, E-LT-003, KNE001.

4 CABLES CLASSIFICATION

In Table 1 a general description of types of cables depicted in this standard are summarized.
Detailed characteristics are described in section 5.

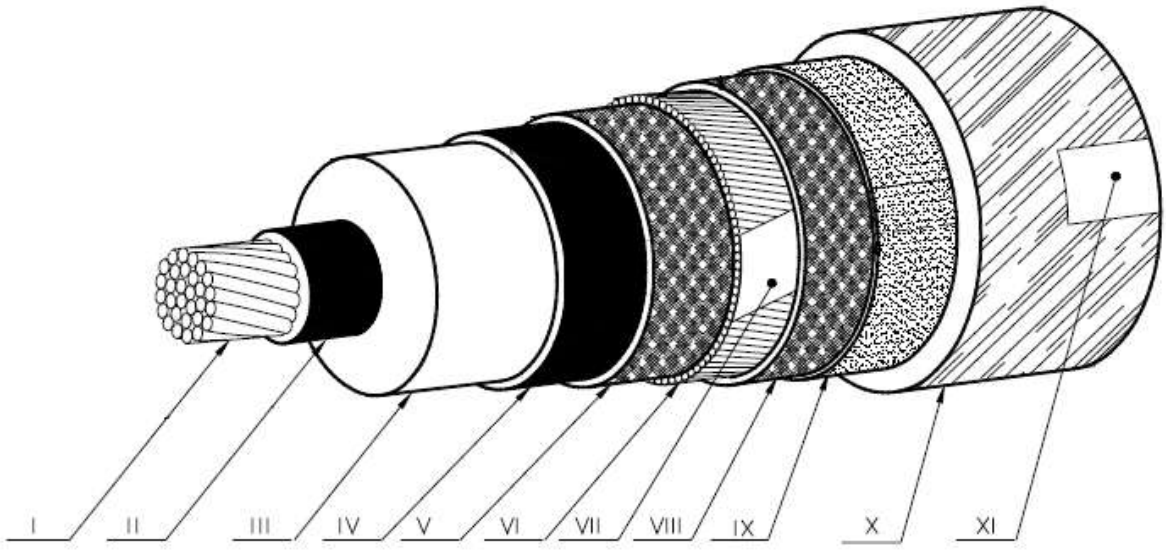
TYPE	DESCRIPTION
I	Single-core cables, with aluminium/copper compacted conductor class 2, cross-linked polyethylene (XLPE), copper or aluminium wires plus aluminium tape earth screen and polyolefin outer sheath with flame propagation features and halogen free.
II	Single-core cables, with aluminium/copper compacted conductor class 2, cross-linked polyethylene (XLPE), smooth aluminium sheath earth screen and polyolefin outer sheath with flame propagation features and halogen free.

Table 1 Type of cables

Those types of cables are intended for their use in the rated voltages included in Table II:

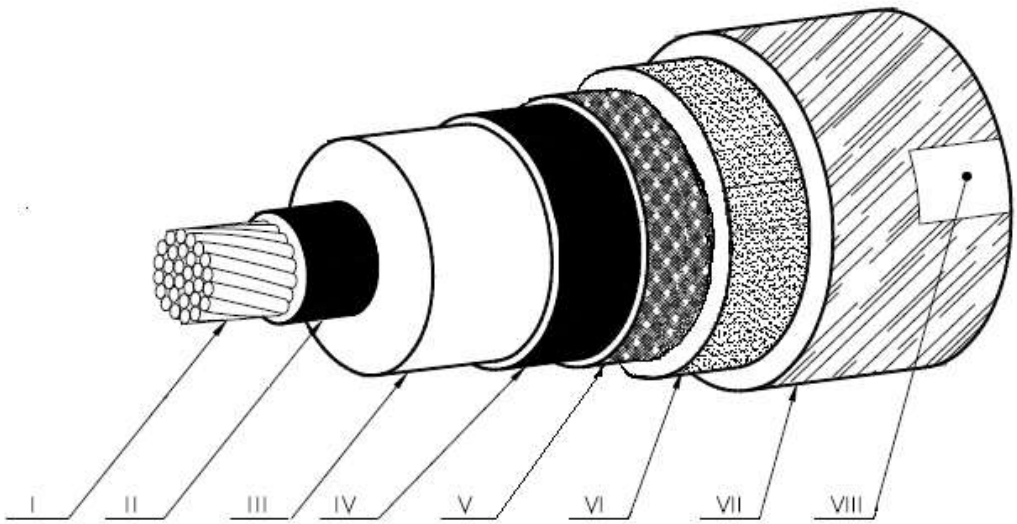
	Unified voltage values U [kV]									
	220	150	138	132	115	110	69	66	60	45
I&N Argentina	X			X						
I&N Brazil			X				X			
I&N Chile	X					X				
I&N Colombia					X					
I&N Iberia				X		X		X		X
I&N Italy	X	X		X						
I&N Peru	X							X	X	
I&N Romania						X				
Cable rated vol. U_0 Cable highest vol. U_m	127 245	87 170	76 145				36 72,5			26 52
	Argentina Chile Italy Peru	Italy Romania	Argentina Brazil Chile Colombia Iberia				Brazil Iberia Peru			Iberia

Table 2 Rated Voltage Cable



I –Conductor
II – Conductor screen
III –Insulation
IV – Insulation screen
V - watertight layer
VI– wires earth screen
VII– equalizer tape
VIII- watertight layer
IX- aluminum foil
X - Outer sheath
XI – Marking

Figure 1 Type I single-core cable with copper or aluminum wires earth screen



I –Conductor	IV – Insulation screen	VII - Outer sheath
II – Conductor screen	V - watertight layer	VIII – Marking
III –Insulation	VI- smooth aluminium sheath	

Figure 2 Type II single-core cable with smooth aluminium sheath earth screen

5 DESIGN AND MANUFACTURE

5.1 Conductor

5.1.1 Aluminum conductors

The aluminum conductors shall be stranded compacted circular class 2, complying all the features specified herein and in standard CEI EN 60228/ IEC 60228. Conductor material shall be AAC-1350, i.e. 99,5% aluminum content.

In Table 3 aluminum conductors for cables specified in this document are depicted.

		U=220 kV	U=150 kV	U=138 kV	U=69 kV	U=45 kV
Cross section Al [mm²]	**400***					400*
	630		630	630	630	
	800	800		800	800	800
	1000	1000	1000	1000	1000	
	1200			1200		
	1600	1600	1600	1600		
	2000	2000		2000	2000	
	2500*	2500*				

* Sections not included in Policy Nº332

Table 3 Standardized aluminium conductor sections

5.1.2 Copper conductors

The copper conductors shall be stranded compacted circular class 2, complying all the features specified herein and in standard CEI EN 60228/ IEC 60228. Copper purity shall not be less than 99,9%

In Table 4 copper conductors for cables specified in this document are depicted.

		U=138 kV	U=69 kV
Cross section Cu [mm²]	**630**	630	
	1200	1200	1200
	1600	1600	
	2000	2000	

Table 4 Standardized copper conductor sections

5.1.3 Maximum Electric resistance at 20 °C

	Maximum Electric Resistance at 20 °C [W/Km]	
Cross section [mm²]	**Aluminium**	**Copper**
400*	**0,0778**	*0,0470*
630	**0,0469**	**0,0283**
800	**0,0367**	*0,0221*
1000	**0,0291**	*0,0176*
1200	**0,0247**	**0,0151**
1600	**0,0186**	*0,0113*
2000	**0,0149**	*0,0090*
2500*	**0,0127**	*0,0072*

Table 5 Stranded compacted conductor characteristics

Conductors of cross section higher than 1000 mm² must be of the Milliken segmental type with a minimum of four segments.

5.2 Conductor screen

It shall consist of a fully bonded layer of black semi-conductive cross-linked compound. It shall be extruded over the conductor to provide a smooth surface without causing any damage to the conductor or insulation and ensuring material compatibility.

The conductor screen nominal thickness shall be 1,5 mm.

The conductor screen minimum thickness measured and accepted at any point shall not be less than 1,2 mm. In addition, the average of all the measures shall not be less than the nominal thickness (1,5 mm).

The resistivity of extruded semi-conducting screens applied over the conductor shall not exceed 1.000 Ω·m.

5.3 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 it without creating any damage to the conductor.

The insulating material shall be cross-linked polyethylene; compliant with the characteristics required herein this document. Such XLPE compound complies all the characteristics described in Standard IEC 60502-2 and standard HD 620 S2 part 1 for DIX 3 compound.

The XLPE insulation must allow maximum conductor temperatures of 90 °C in normal operation and 250 °C under short circuit condition by at least 0,5 seconds.

The insulation minimum thickness measured and accepted at any point of the cable shall not be less than 90% of the nominal value

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

And:

$$\frac{tmax - tmin}{tmax} \leq \begin{cases} 0.10\ for\ cables\ with\ U_0 = 127\ kV \\ 0.15\ for\ cables\ with\ U_0 < 127\ kV \end{cases}$$

Where:

t_{min}: minimum insulation thickness in millimeters

t_{max}: maximum insulation thickness in millimeters

t_n : nominal thickness in millimeters

In Table 6 nominal and minimum thickness for XLPE insulated cables are shown.

Rated Voltage Uo/U (Umax) [kV]	Insulation thickness	
	Nominal (t_n) [mm]	Minimum (t_{min}) [mm]
26/45 (52)	7	6,3
40/69 (72.5)	9	8,1
80/138 (145)	16	14,4
87/150 (170)	18*	16,2
127/220 (245)	21	18,9

Table 6 Insulation thickness values

* For 87/150 (170) kV cables, nominal and minimum thickness could be smaller for conductor sections larger than 630 mm^2

5.4 Insulation screen

A black layer of cross-linked semi-conductive compound shall be applied over the insulation. Such layer shall be compatible with insulation temperatures in normal operation and during short circuit.

The insulation screen shall be adhered to the insulation.

Unless otherwise indicated in the Common List, the insulation screen minimum thickness measured and accepted at any point shall not be less than 1,2 mm. In addition, the average of all the measures shall not be less than the nominal thickness (1,5 mm).

The resistivity of extruded semi-conducting screen applied over the insulation shall not exceed 500 Ω·m.

5.5 Conductor screen, Insulation and Insulation screen application

The conductor screen, the insulation and the insulation screen shall be extruded in one operation, i.e. triple extrusion process. It is not permitted using any type of lacquer or other material between this layers.

5.6 Longitudinal water-tightness swelling tape.

A swelling tape made of suitable semi-conductive material shall be applied between the insulation screen and the earth screen in order to achieve longitudinal water-tightness. Such tape shall be applied without harming the adjacent layers and could work as additional separator layer as well. The swelling tape shall be applied with a minimum overlap same as 10%.

5.7 Earth screen

For **Type I** cables a copper wire screen with equalizer copper tape shall be applied over the overlapped semi-conductive swelling tape. The copper screen shall be made with a continuous crown of annealed copper wires

arranged in a helix with an equalizer tape with a minimal nominal section of 1 mm^2 and with step not greater than 4 times the crown diameter. It shall be used at least 50 wires distributed evenly over the circumference. The total section of the copper wires and their maximum electric resistance at 20ºC shall be one of those indicated in Table 7.

A swelling tape made of suitable semi-conductive material shall be applied over the earth screen in an open helix to make possible the contact between earth screen and aluminum tape.

About the relationship between screen short circuit current and screen cross section at different voltages refers to the chart of Annex B.

For special cases according to the project it is possible to use screens of greater section than those indicated in table N ° 7

As an alternative, aluminium could be used instead of cooper in order to made the wire screen indicated before. The maximum electric resistances remain the same, so the minimum aluminium section are those indicated in Table 7.

For **Type II** cables an aluminium tape screen forming a butt welded longitudinal pipe bonded to the oversheath shall be applied over the overlapped semi-conductive swelling tape. The maximum electric resistance at 20ºC shall be the same as those of Type I cables so the total section of aluminium tube shall be equal or greater than one of those indicated in Table 7.

For Type II cables, the aluminium tube prevents radial water propagation and there is no necessity of the aluminium tape indicated in 5.8.

Copper Section [mm^2]	**Maximum Electric Resistance at 20 °C [W/Km]**	**Equivalent Al section [mm^2]**
240	0,0745	363
200	0,086	303
160	0,216	242
120	0,149	182
95	0,188	144
50	0,357	76

Table 7 Screen Sections

5.7.1 Alternatives screens

Other kinds of metallic screen with equivalent functional characteristics may be used as an alternative in each of the codes included in this standard, provided that they have the prior acceptance of Enel

5.8 Radial water tightness

Just for Type I cables. A longitudinally applied aluminium laminate foil with minimum thickness of 0.1 mm shall be applied bonded to the outer sheath against radial water-tightness. A suitable overlap shall be glued to avoid sheath damages.

There must be electrical contact between this aluminum tape and the wires of the earth screen.

5.9 Outer Sheath

The outer sheath shall be resistant to moisture, abrasion and UV.

Unless otherwise indicated the outer sheath color shall be black RAL 9005.

The material shall be a polyolefin type ST7 with some additive to give flame retardant features.

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..

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

Where:

t_{min}: minimum thickness in millimeters

t_n: nominal thickness in millimeters

In Table 8 rated and minimum thickness of the polyolefin outer sheath are shown.

Cross-section [mm^2]	Sheath nominal thickness [mm]	Sheath minimum thickness [mm]
400*	3,5	2,88
630	3,5	2,88
800	3,8	3,13
1000	4	3,3
1200	4	3,3
1600	4,5	3,73
2000	4,5	3,73
2500*	4,5	3,73

Table 8 Type I and Type II PO outer sheath thickness

There must exist an extruded semi-conductive layer on the oversheath to assist in electrical tests. This layer could be substituted with a graphite coating.

5.10 Ampacity and Short-circuit rating

The ampacity and short-circuit rating **estimated** values shall be given for network design purposes.

Unless otherwise indicated in local sections, such ampacity values shall be calculated in steady state condition, for single core laying and triplex 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 1,5 m
- Soil thermal resistivity 1,5 K m/W
- Both end bonding

Estimated values of steady state ampacity of single circuits directly buried of cable types included in this standard are depicted in Annex C.

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the following conditions:

- Conductor initial temperature 90 °C
- Conductor final temperature 250 °C
- Tape foil screen initial temperature 75 °C
- Tape foil screen final temperature 150 °C
- Copper wires screen initial temperature 80 °C
- Copper wires screen final temperature 180 °C
- Short-circuit duration: 0,5 s and 1 s

For reference values see local section.

5.11 Cable designation and marking

5.11.1 Cable designation

If not specified otherwise in Local Section, designation of the cable is formed by the following terms:

- "ENEL GSCH010".
- Voltage level U_0/U (Um) and "kV",
- "XLPE",
- "1X" and section of the conductor (expressed in mm^2), and its material (Cu or Al),
- + a character representing the type of cable (H: for Type I, T: for Type II)
- Nominal section of screen (expressed in mm^2),
- "Al", (just for cable type II screen made of aluminium wires),

Designation example for cable GSCH010/01:

ENEL GSCH010 - 127/220 (245) kV - XLPE - 1x2500 Al + T363

5.11.2 Marking

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

Durability shall be checked by the test given in sub-clause 4.4 of standard IEC 60794-1-21.

If not specified otherwise in Local Section, marking should include the following information:

- Designation of the cable as indicated in paragraph 5.11.1.
- Manufacturer's name and trademark,
- Year of production,
- Number of production batch.
- Metric.

The print will be made every 0.5 meters and with a font size of not less than 10 mm

Marking example for cable GSCH010/01:

ENEL GSCH010 - 127/220 (245) kV - XLPE - 1x2500 Al + T363 - Manufacturer - 2018- Nº P.B. - 0000

6 CONDITIONS OF SUPPLY

The samples needed for tests shall be taken from additional lengths of the same batch included in the supply order. Thereby, the lengths in any contract could not be diminished in order to perform any test. The allowed tolerance of the cable length provided on each drum is -0%, +1% of the nominal length required.

The cable will be provided with caps on its ends to ensure tightness.

If not specifically indicated otherwise, the cable will be issued in metal drums and with staves of the same material or wood. Both treated to avoid corrosion.

Drums shall be designed to bear the weight of the cable corresponding to its length without any deformation that could damage the cable inside.

Particular care shall be taken to design the drums taking into account the operator's safety in field during installation and handling.

The drawings of the drums shall be provided to Enel for approval.

The drums shall be marked with the following information:

a) Destination.

b) Order number or purchase order.

c) Manufacturer or brand.

d) Country of origin.

d) Length of the cable in the coil.

e) Type and size of the conductor.

f) Thickness and type of insulation.

g) Nominal voltage.

h) Weights, tare and net.

i) Year of manufacture.

For further details see the local sections

7 GUARANTEE

Requirement of warranty will be indicated in the request for bids, indicating periods and standards.

8 TESTS

8.1 Test classification

8.1.1 Acceptance tests

Acceptance tests (routine tests and sample tests) shall be carried out in the Supplier's facilities.

8.1.2 Routine tests

Routine tests shall be performed at 100% of delivered spools to demonstrate product integrity.

8.1.3 Sample tests

Sample tests are carried out over samples taken from each batch (manufacturing series) in order to verify that the finished product meet the design specifications.

8.1.4 Type tests

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 cable covered herein with a specific cross-section, rated voltage and construction characteristics, the type approval could 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.
- The cable has similar constructions as that of the tested cable, i.e. utilizes same materials, (conductor, screens, insulation, earth screen, outer sheath) and the same manufacturing process.
- The rated voltage not exceeds that of the tested cable.
- The calculated nominal electrical stress and the impulse voltage stress calculated using nominal dimensions at the cable conductor screen do not exceed the respective calculated stresses of the tested cable by more than 10 %.

- The calculated nominal electrical stress at the cable insulation screen and the impulse voltage stress calculated using nominal dimensions do not exceed the respective calculated stresses of the tested cable.

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

Cables shall undergo type tests after having passed all the acceptance tests gathered in routine and sample tests lists.

All samples needed for the type tests shall be taken from the same production length.

The type tests shall comprise the electrical tests on the complete cable system and the non-electrical test on cable components and complete cable as specified in 8.5 and 8.6. For cables with $U_{max} \leq 170$ kV, calculated nominal electrical stress at the conductor screen not higher than 8,0 kV/mm and calculated nominal electrical stress at the insulation screen not higher than 4,0 kV/mm the electrical tests should be performed on cables alone.

The type tests on cable components only need to be carried out on samples from cables of different voltage ratings and/or conductor cross-sectional areas if different materials and/or different manufacturing processes are used to produce them. However, repetition of the ageing tests on pieces of completed cable to check compatibility of materials may be required if the combination of materials applied over the screened core is different from that of the cable on which type tests have been carried out previously.

8.1.5 Prequalification tests

Prequalification tests shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory long term performance of the complete cable system.

The prequalification test shall be performed on cable systems where the calculated nominal electrical stresses at the conductor screen will be higher than 8,0 kV/mm and/or at the insulation screen higher than 4,0 kV/mm. The prequalification test shall be performed except if cable systems with the same construction and accessories of the same family have been prequalified for a higher rated voltage.

Prequalification test must be performed on a cable system, using a cable of a large conductor cross-section in order to cover thermos-mechanical aspects. General conditions for these tests and their extension are those indicated in IEC 62067 clause 13 for cables with U_0=127 kV and IEC 60840 clause 13 for cables with U_0<127 kV.

8.1.6 Development tests

These are tests made during the development of a cable design and shall be performed before supplying a type of cable covered by this standard in order to demonstrate satisfactory performance of the complete cable system.

8.2 Sampling and acceptance criteria

The sample tests shall be carried out on one length from each batch (manufacturing series) of the same type and cross-section of cable, but shall be limited to not more than 10 % of the number of lengths in any contract, rounded to the nearest whole number.

If the sample from any length selected for the tests fails in any of the tests, further samples shall be taken from two further lengths of the same batch and subjected to the same tests as those in which the original sample failed. If both additional samples pass the tests, the other cables in the batch from which they were taken shall be regarded as having complied with the requirements of this standard. If either fails, this batch of cables shall be regarded as having failed to comply

8.3 Routine tests list

8.3.1 Partial discharge test

Requirements: No detectable discharge exceeding sensitivity of 10 pC or better at 1.5 U_0

Test method: IEC 60840 clause 9.2

8.3.2 Voltage test

Requirements: No breakdown of the insulation shall occur.

Test method: IEC 60840 clause 9.3

Test voltage: 2.5 U_0

Duration: 30 min

8.3.3 Electrical test on oversheath of the cable

Requirements: No breakdown.

Test method: IEC 60229 clause 3

Test voltage: 25 kV DC

Duration: 1 min

8.3.4 Measurement of electrical resistance of conductor and metal screen

Requirements: ≤ nominal value

Test method: IEC 60840 clause 10.5

8.3.5 Measurement of capacitance

Requirements: ≤ 1.08 declared nominal value

Test method: IEC 60840 clause 10.10

8.4 Sample tests list

8.4.1 Cable examination

Requirements: Conformity to constructive characteristics, i.e.: marking, colors, number of conductor wires, insulation and outer sheath application, etc.

Test method: inspection by visual examination

8.4.2 Measurement of thickness of cable insulation and oversheath

Requirements:

Insulation: Clause 5.3.

Oversheath: Clause 5.9

Test method: IEC 60811-201, IEC 60811-202

8.4.3 Measurement of thickness of metal sheath

Requirements: declared nominal value.

Test method: IEC 608410 clause 10.7.2

8.4.4 Measurement of diameters

Requirements: declared nominal value for conductor, over insulation and overall diameter.

Test method: IEC 60811-203

8.4.5 Hot set test for XLPE insulation

Treatment:

Air Temperature: 200 ºC ± 3 K

Time under load: 15 min

Mechanical stress: 0,2 MPa

Requirements:

Maximum elongation under load: 175%

Maximum permanent elongation after cooling: 15%

Test method: IEC 60811-507

8.4.6 Lightning impulse voltage test

For cables with U_0=127 kV or with a nominal electric conductor stress > 8,0 kV/mm

Frequency: one test for contracts with a cable length between 4 km and 20 km and two tests for contracts with longer cable lengths

Requirements: No breakdown of the insulation shall occur

Test method: IEC 62067 clause 10.12

Impulse lighting voltage value:

250 kV for cables with U_{max} = 52 kV.

350 kV for cables with U_{max} = 72.5 kV.

650 kV for cables with U_{max} = 145 kV.

750 kV for cables with U_{max} = 170 kV.

1.050 kV for cables with U_{max} = 245 kV.

8.4.7 Water penetration test

Frequency: one test for contracts with a cable length between 4 km and 20 km and two tests for contracts with longer cable lengths

Requirements and test method:

IEC 62067 Annex E for cables with U_0=127 kV

IEC 60840 Annex E for cables with U_0<127 kV

8.4.8 Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath

Tests included:

Visual examination

Adhesion strength of metal foil

Peel strength of overlapped metal foil

Requirements and test method: IEC 60840 Annex F

8.4.9 Measurement of thickness of conductor and insulation screens

Requirements:

Conductor screen: Clause 5.2.

Insulation screen: Clause 5.4

Test method: IEC 60811-202

8.4.10 Mechanical properties of XLPE insulation

Requirements:

Minimum tensile strength: 12,5 MPa

Minimum elongation at break: 200%

Test method: IEC 60811-501

8.4.11 Mechanical properties of sheath

Requirements:

Minimum tensile strength: 12.5 MPa

Minimum elongation at break: 300%

Test method: IEC 60811-501

8.4.12 Abrasion resistance of cable markings

Requirements:

The marking shall be legible after 500 cycles of Method 2 with an applied force of 15 N

Test method: IEC 60794-1-21 sub clause 4.4

8.5 Electrical Type Tests list

8.5.1 Bending test

The following sequence shall be carried out:

a) Bending test on the cable

Test method: IEC 60840 sub-clause 12.4.3

b) Installation of accessories

For electrical type tests on cables alone accessories could be just the test terminations

c) Partial discharge test at ambient temperature

Requirements: No detectable discharge exceeding sensitivity of 5 pC or better at 1.5 U_0

Test method: IEC 62067 sub-clause 12.4.4

8.5.2 Tan δ measurement

Requirements: Tan $\delta \leq 10 \cdot 10^{-4}$

Test method: IEC 60840 clause 12.4.5

8.5.3 Heating cycle voltage test

Requirements:

Test method:

IEC 62067 clause 12.4.6 for cables with U_0=127 kV

IEC 60840 clause 12.4.6 for cables with U_0<127 kV

8.5.4 Partial discharge test at ambient and high temperature

This test shall be carried out after the final cycle of test in 8.5.3 or, alternatively, after the test in 8.5.5

Requirements: No detectable discharge exceeding sensitivity of 5 pC or better at 1.5 U_0

Test method: IEC 60840 clause 12.4.4

8.5.5 Lightning impulse voltage test followed by a power frequency voltage test

Requirements: No breakdown of the insulation or flashover shall occur

Test method:

IEC 62067 clause 12.4.7.2 for cables with U_0=127 kV

IEC 60840 clause 12.4.7 for cables with U_0<127 kV

Impulse lighting voltage value:

250 kV for cables with U_{max} = 52 kV.

350 kV for cables with U_{max} = 72.5 kV.

650 kV for cables with U_{max} = 145 kV.

750 kV for cables with U_{max} = 170 kV.

1.050 kV for cables with U_{max} = 245 kV.

Power frequency voltage value:

65 kV for cables with U_{max} = 52 kV.

90 kV for cables with U_{max} = 72.5 kV.

190 kV for cables with U_{max} = 145 kV.

218 kV for cables with U_{max} = 170 kV.

254 kV for cables with U_{max} = 245 kV.

8.5.6 Partial discharge test at ambient and high temperature

If not previously carried out after the final cycle of test in 8.5.3

Requirements: No detectable discharge exceeding sensitivity of 5 pC or better at 1.5 U_0

Test method: IEC 60840 clause 12.4.4

8.5.7 Examination of cable

Requirements: No signs of deterioration

Test method: IEC 60840 clause 12.4.8

8.5.8 Resistivity of cable semi-conducting screens

This test shall be made on a separate sample

Requirements: Resistivity, before and after ageing, shall not exceed the values in 5.2 and 5.4.

Test method: IEC 60840 clause 12.4.9

8.6 Non Electrical Type Tests list

8.6.1 Check of cable construction

Requirements: Conformity to declared values

Test method: IEC 60840 clause 12.5.1

8.6.2 Mechanical properties of insulation before and after ageing

Requirements:

Without ageing:

Minimum tensile strength: 12,5 N/mm^2

Minimum elongation at break: 200%

After ageing in air oven at 135ºC ± 3K during 168 h:

Maximum variation tensile strength: ±25%

Maximum variation elongation at break: ±25%

Test method: IEC 60840 clause 12.5.2

Sampling, conditioning and mechanical tests: IEC 60811-501.

Ageing treatment: IEC 60811-401.

8.6.3 Mechanical properties of oversheath before and after ageing

Requirements:

Without ageing:

Minimum tensile strength: 12,5 N/mm^2

Minimum elongation at break: 300%

After ageing in air oven at 110ºC ± 2K during 240 h:

Minimum elongation at break: 300%

Test method: IEC 60840 clause 12.5.3

Sampling, conditioning and mechanical tests: IEC 60811-501.

Ageing treatment: IEC 60811-401.

8.6.4 Ageing tests on pieces of complete cable to check compatibility of materials

Treatment:

Air oven temperature: 100 ºC ± 2 K

Duration: 7 X 24 hours

Requirements: IEC 60840 clause 12.5.4.5

Test method: IEC 60840 clause 12.5.4

Sampling, conditioning and mechanical tests: IEC 60811-501.

Ageing treatment: IEC 60811-401.

8.6.5 Pressure test at high temperature on oversheath

Requirements: IEC 60811-508

Test method: IEC 60811-508 with test temperature 110ºC ± 2K

8.6.6 Hot set test for XLPE insulation

Treatment:

Air Temperature: 200 ºC ± 3 K

Time under load: 15 min

Mechanical stress: 0,2 MPa

Requirements:

Maximum elongation under load: 175%

Maximum permanent elongation after cooling: 15%

Test method: IEC 60811-507

8.6.7 Measurement of carbon black content of black PE oversheaths

The extruded semi-conductive layer has to be excluded

Requirements: 2,5 ± 0,5 %.

Test method: IEC 60811-605

8.6.8 Test under fire conditions

Requirements: Flame retardant

Test method: IEC 60332-1-2

8.6.9 Water penetration

Requirements and test method:

IEC 62067 Annex E for cables with U_0=127 kV

IEC 60840 Annex E for cables with U_0<127 kV

8.6.10 Tests on components of cables with a longitudinally applied metal tape or foil, bonded to the oversheath

Tests included:

Visual examination

Adhesion strength of metal foil

Peel strength of overlapped metal foil

Requirements and test method: IEC 60840 clause 12.5.15

8.6.11 Shrinkage test for XLPE insulation

Requirements:

Distance L between marks: 200 mm.

Temperature: 130 ºC ± 3 K

Duration: 6 h.

Maximum permissible shrinkage 4,5%

Test method: IEC 60811-502

8.6.12 Shrinkage test for PE oversheaths

Requirements:

Test Temperature: 80 ºC ± 2 K

Duration: 5 h.

Number of heating cycles: 5

Maximum permissible shrinkage: 3%

Test method: IEC 60811-503

8.6.13 Oversheath halogen acid content

Requirements: < 5 mg./g.

Test method: IEC 60754-1

8.7 Prequalification tests list

8.7.1 Heating cycle voltage test

Requirements: No breakdown shall occur.

Test voltage: 1,7 U_0

Cycles: ≥ 180

Test method:

IEC 62067 clause 13.2.4 for cables with U_0=127 kV

IEC 60840 clause 13.2.4 for cables with U_0<127 kV

8.7.2 Lightning impulse voltage test

Requirements: withstand 10 positive and 10 negative voltage impulses without failure

Test voltage:

250 kV for cables with U_{max} = 52 kV.

350 kV for cables with U_{max} = 72.5 kV.

650 kV for cables with U_{max} = 145 kV.

750 kV for cables with U_{max} = 170 kV.

1.050 kV for cables with U_{max} = 245 kV.

Test method:

IEC 62067 clause 13.2.5 for cables with U_0=127 kV

IEC 60840 clause 13.2.5 for cables with U_0<127 kV

8.7.3 Examination of the cable system after completion of the tests above

Requirements: No signs of deterioration

Test method: IEC 60840 clause 13.2.6

8.8 Development tests list

8.8.1 Impact test

Requirements: IEC TR 61901 clause 4.1.1

Type I cables: no cracks or separation of the aluminium foil of laminated protective coverings or harmful damage to other parts of the cable

Height: 1 m.

Weight: 5 kg.

Radius: 2 mm.

Number of impacts per location: 1.

Number of locations: 5.

Type II cables: There should be no puncture at the points of impact and the semi-conductive screen should not be deformed by more than 1 mm and should not show a deflection having a sharp angle into the insulation at the point of impact.

Height: 0,27 m.

Weight: 27 kg.

Radius: 1 mm.

Number of impacts per location: 4.

Number of locations: 2

Test method: IEC TR 61901 clause 4.1.1

8.8.2 Sidewall loading test

This test shall be carried out if the quotient between maximum pulling force and minimum bending radius during installation is greater than the one indicated below:

For Type I cables: 1.000 daN/m.

For Type II cables: 2.500 daN/m.

Requirements: IEC TR 61901 clause 4.1.3

Visual inspection should reveal no cracks or separation of protective coverings or harmful damage to any parts of the cable.

Test method: IEC TR 61901 clause 4.1.3

8.8.3 Long term ageing of adhesive bonds of components of laminated covering

Requirements: IEC TR 61901 clause 4.1.4

Test method: IEC TR 61901 clause 4.1.4

8.8.4 Mechanical properties of the welding

Just for Type II cables.

Requirements: IEC TR 61901 clause 4.1.5

Test method: IEC TR 61901 clause 4.1.5

8.8.5 Short circuit test

The short circuit test shall be performed on cable systems including cable, connection to accessories, the accessories, the grounding connection, and the grounding cables.

Requirements: IEC TR 61901 clause 4.1.5

Test method: IEC TR 61901 clause 4.1.5

9 TECHNICAL CHECK-LIST

The following chart indicates the minimum technical information that suppliers shall provide.

Item	Description	Unit	Required	Offered
1	**GENERAL INFORMATION**			
1.1	Supplier	-	Info	
1.2	Factory	-	Info	
1.3	Location of factory	-	Info	
2	**MAIN FEATURES**			
2.1	Distribution Company and Country	-		
2.2	Country Code	-		
2.3	GS Type Code			
2.4	Nominal Voltage Uo/U (Umax)	[kV]		
2.5	Type I or Type II	-		
2.6	Designation	-		
3	**CONDUCTOR**			
3.1	Material	-		
3.2	Nominal cross-section	[mm^2]		
3.3	Stranding Type	-		
3.4	Minimum diameter of conductor	[mm]		
3.5	Maximum diameter of conductor	[mm]		
3.6	Number of wires of conductor	-		
3.7	Nominal diameter of wires	[mm]		
3.8	Conductor DC resistance at 20°C	[Ω/ km]		
3.9	Watertightness measures	-		
3.10	Measures taken to reduce skin effect	-		
4	**CONDUCTOR SCREEN**			
4.1	Material			
4.2	Nominal thickness	[mm]		
4.3	Minimum thickness	[mm]		
4.4	Volume resistivity	[Ω · m]		
4.5	Calculated nominal electrical stress	[kV/mm]		
5	**INSULATION**			
5.1	Material	-		
5.2	Nominal thickness	[mm]		
5.3	Minimum thickness	[mm]		
5.4	Nominal inner diameter	[mm]		

Item	Description	Unit	Required	Offered
5.5	Nominal outer diameter	[mm]		
5.6	Color	-		
5.7	Special additives	-		
6	**INSULATION SCREEN**			
6.1	Material			
6.2	Nominal thickness	[mm]		
6.3	Minimum thickness	[mm]		
6.4	Volume resistivity	[Ω · m]		
6.5	Calculated nominal electrical stress	[kV/mm]		
7	**MANUFACTURING PROCESS FOR INSULATION SYSTEM**			
7.1	Type of extrusion			
7.2	Type of extrusion line			
7.3	Identification of extrusion line			
7.4	Curing means			
7.5	Cooling means			
8	**LONGITUDINAL WATER-TIGHNESS SWELLING TAPE**			
8.1	Material			
8.2	Nominal thickness	[mm]		
8.3	Nominal width	[mm]		
8.4	Overlapping	[%]		
9	**EARTH SCREEN (Type I cables)**			
9.1	Material of wires / tapes			
9.2	Number of wires			
9.3	Nominal wires diameter	[mm]		
9.4	Helix pitch	[mm]		
9.5	Number of tapes			
9.6	Thickness and width of tape	[mm]		
9.7	Nominal cross-section	[mm2]		
9.8	External diameter	[mm]		
9.9	DC resistance at 20°C	[Ω/ km]		
9.10	Semiconductive swellling tape material			
9.11	Semiconductive swellling tape thickness	[mm]		
9.12	Semiconductive swellling tape width	[mm]		
9.13	Aluminum foil bonded to oversheath nominal thickness	[mm]		
10	**EARTH SCREEN (Type II cables)**			
10.1	Material			
10.2	Manufacturing process			

Item	Description	Unit	Required	Offered
10.3	Nominal thickness	[mm]		
10.4	Minimum thickness	[mm]		
10.5	Nominal cross-section	[mm2]		
10.6	External diameter	[mm]		
10.7	Maximum DC resistance at 20°C	[Ω/ km]		
11	**OUTER SHEATH**			
11.1	Sheat material			
11.2	Nominal thickness			
11.3	Minimum thickness			
11.4	Color			
11.5	Material designation			
11.6	Semiconductive extruded skin thickness	[mm]		
11.7	Graphite coating applied			
11.8	Marking			
12	**ADDITIONAL FEATURES**			
12.1	Nominal overall diameter of the cable	[mm]		
12.2	Minimum radius of curvature during laying	[mm]		
12.3	Minimum radius of curvature not tractioned	[mm]		
12.4	Maximum permissible pulling force	[daN]		
12.5	Total weight	[kg/m]		
12.6	Fire retardant (IEC 60332-1-2)			
12.7	Fire reaction Class (EN 50575 if apply)			

LOCAL SECTION A – Enel Distribución Argentina

5.1 Conductor

Watertight round stranded and compacted conductor.

5.10 Ampacity and Short-circuit rating

The ampacity and short-circuit rating **estimated** values shall be given for network design purposes.

For Argentina, such ampacity values shall be calculated using the following operational conditions:

- Ground temperature: 25 °C
- Depth of laying: 2 m
- Soil thermal resistivity: 1 K°m/W
- Screens connection: Cross bonding and single point,,

LOCAL SECTION B – Enel Distribución Colombia

Local Standard.

RETIE: Reglamento técnico de instalaciones eléctricas

Instalation conditions for Colombia.

Item	Codensa
Altitud Máxima (m)	2850
T° Mínima (°C)	-5°
T° Maxima (°C)	40°
T° Media (°C)	30°
Profundidad de la instalación (m)	1.5/2.0
Nivel de humedad (%)	96
Humedad relativa media (%)	75
Nivel de contaminación (IEC 60815)	Medio
Radiación solar máxima (Wb/m^2)	1000

LOCAL SECTION C – Enel distribución Perú

ITEM	TITLE	DESCRIPTION
5.10	Ampacity and Short-circuit rating	for Peru, shall be the following operation conditions: • Maximum conductor temperature 90 °C • Maximum ambient air temperature 40 °C • Minimum ambient air temperature -5 °C • Medium ambient air temperature 30 °C • Ground temperature XXXXX • Depth of laying 1,7 m • Soil thermal resistivity 1,5 K m/W • directly underground • humidity 100% • maximum wind pressure 700 N/m^2 • level of pollution, very high • maximum solar radiation, 1000 Wb/m^2 • seismic conditions, • Both end bonding Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the following conditions: • Conductor initial temperature 90 °C • Conductor final temperature 250 °C • Tape foil screen initial temperature 75 °C • Tape foil screen final temperature 150 °C • Copper wires screen initial temperature 80 °C • Copper wires screen final temperature 180 °C • Short-circuit duration: 0,5 s and 1 s

ITEM	TITLE	DESCRIPTION
5.11.1	Cable designation	For Peru CU: copper conductor R: round stranded E4: XLPE cross-linked poliethylene insulation H1: cooper wires earth screen PO: Polyolefin Rated Voltage: Uo/U (Umax) Conductor section: 1x XXX mm^2 Example: CURE4H1PO 36/66(72.5) 1x500MM^2
5.11.2	Marking	For Peru: The outer sheath should be marked with high aligned characters. The distance between the end of a brand and the same brand successive must comply with the provisions of document HD-620-10I2 2.11.2 and shall contain, in the order listed. The following information shall be marked: • Name of Distribution Company (Enel Distribución Peru) • Name of the Manufacturer (XXXX) • Cable designation • The year and month of manufacture • the metric could be indicated at a distance less than 1 meter Asimismo: • el tamaño de la letra deberá ser ≥ 10 mm. • between each marking there must be a distance no greater than 0.5 m Printing example ENEL DISTRIBUCIÓN PERU (XXXX) CURE4H1PO 36/66(72.5) 1x500MM^2 2017 12 0000

<table>
<tr><th>ITEM</th><th>TITLE</th><th>DESCRIPTION</th></tr>
<tr><td>6</td><td>CONDITIONS OF SUPPLY</td><td>
For Peru:
<u>Longitud de entrega de cables:</u>
El cable se entregará en los largos de fabricación de acuerdo a cada proyecto de obra, teniendo en cuenta su propio peso por metro, de manera que no supere en ningún caso el esfuerzo máximo de tiro garantizado por el fabricante.
Sólo se permitirá una tolerancia de ± 5% de la longitud solicitada en el proyecto,
En ningún caso de tomará muestras para los ensayos del lote del proyecto.

The coils will be according to the following information:

<table>
<tr><th>ITEM</th><th>DESCRIPCION</th><th>UNIDAD</th><th>SOLICITADO
60 kV</th><th>OFRECIDO</th><th>OBS.</th></tr>
<tr><td>1</td><td>Nombre del fabricante</td><td>-</td><td></td><td></td><td>(*)</td></tr>
<tr><td>2</td><td>Modelo (designación de la fábrica)</td><td>-</td><td>Inf. Fabricante</td><td></td><td>(*)</td></tr>
<tr><td>3</td><td>País de origen</td><td>-</td><td>Inf. Fabricante</td><td></td><td>(*)</td></tr>
<tr><td>4</td><td>Norma de construcción y ensayo</td><td>-</td><td>Inf. Fabricante</td><td></td><td>(*)</td></tr>
<tr><td>5</td><td>Diámetro exterior del carrete</td><td>mm</td><td>Máx. 3900</td><td></td><td>(**)</td></tr>
<tr><td>6</td><td>Diámetro interior del carrete</td><td>mm</td><td>Inf. Fabricante</td><td></td><td>(*)</td></tr>
<tr><td>7</td><td>Diámetro del buje</td><td>mm</td><td>150</td><td></td><td>(**)</td></tr>
<tr><td>8</td><td>Ancho del carrete</td><td>mm</td><td>Inf. Fabricante</td><td></td><td>(*)</td></tr>
<tr><td>9</td><td>Material del carrete</td><td></td><td>Hierro</td><td></td><td>(**)</td></tr>
<tr><td>10</td><td>Masa del carrete vacío</td><td>kg</td><td>Inf. Fabricante</td><td></td><td>(**)</td></tr>
<tr><td>11</td><td>Masa del carrete con la longitud nominal del cable</td><td>kg</td><td>Inf. Fabricante</td><td></td><td>(**)</td></tr>
</table>
(*) Concepto a indicar por el oferente
(**) Concepto de cumplimiento obligatorio
</td></tr>
</table>

LOCAL SECTION D – Enel distribución Chile

CONDITIONS OF SUPPLY

- Delivery

Enel Distribución Chile (Referencia Especificación corporativa ENERSIS E-LT-003 Revisión N° 1, ENE 2001).

MARKING

The cable must have at least the following information about the pod with the following writing:

Name of the distributor:
Voltage level: xx kV
Cable type: Type I or Type II.
Conductor section (mm2):
Conductor material (Cu / Al):
Name of the manufacturer:
Year of production:
Purchase order number:

The print will be made every 0.5 meters and with a font size of not less than 10 mm

LOCAL SECTION E – Enel Distribuição Ceará, Rio, Goiás and Eletropaulo

CONDITIONS OF SUPPLY

1 - MARKING

The cable must have at least the following information about the pod with the following writing:

Name of the distributor:
Voltage level: xx kV
Cable type: Type I or Type II.
Conductor section (mm2):
Conductor material (Cu / Al):
Name of the manufacturer:
Year of production:
Purchase order number:

The print will be made every 0.5 meters and with a font size of not less than 10 mm.

2 - AMPACITY AND SHORT-CIRCUIT RATING

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

For Eletropaulo, such ampacity values shall be calculated in steady state condition.

Following operational conditions:

- Maximum conductor temperature 90 °C
- Ambient air temperature -10°C +40 °C
- Ground temperature minimum 5 °C , maximum 25 °C
- Depth of laying minimum 1,5 m, maximum 2 m
- Soil thermal resistivity 1 K° m/W
- screens connected to the system (cross bonding, single point bonding and both ends)

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the following conditions:

- RATED VOLTAGE: 138kV
- SHORT-CIRCUIT DURATION: 1 s
- THREE-PHASE SHORT CIRCUIT CURRENT 40 KA
- PHASE-GROUND SHORT CIRCUIT CURRENT 21 KA
- FREQUENCY 60HZ
- LOAD FACTOR 0,77
- BASIC ISOLATION LEVEL 650 KV

LOCAL SECTION F – e-distribuzione, e-distributie Banat, Dobrogea and Muntenia.

3.1 Laws

NTE 007/08/00 Normativ pentru proiectarea și execuția rețelelor de cabluri electrice

5.10 Ampacity and Short-circuit rating

The ampacity and short-circuit rating **estimated** values shall be given for network design purposes.

For Romania, such ampacity values shall be calculated in steady state condition, for single core laying and triplex 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 -30°C +40 °C
- Ground temperature minimum 5 °C , maximum 25 °C
- Depth of laying minimum 1m, maximum 1,5 m
- Soil thermal resistivity 1 K° m/W
- screens connected to the system ,,cross bonding,,
- At the squad the cables are in contact
- At the layout, the distance between the cables is 50 mm

Regarding short-circuit rating adiabatic and non-adiabatic values shall be calculated using the following conditions:

- Conductor initial temperature 90 °C
- Conductor final temperature 250 °C
- Tape foil screen initial temperature 75 °C
- Tape foil screen final temperature 150 °C
- Copper wires screen initial temperature 80 °C
- Copper wires screen final temperature 180 °C
- Short-circuit duration: 0,5 s

5.12 Cable designation and marking

5.12.1 Cable designation

Sigla ARE4H1H5E 87/150 kV

5.12.2 Marking

On the exterior mantle, there must be a re-embossed printing at least one meter away, in the order indicated, the following inscriptions:

Property sigla followed by:

- ENEL Sigla

- the conductor section
- Manufacturer's name and trademark
- the letter identifying the construction site
- project indices
- year and month of manufacture

Example bookmark:

ENEL ARE4H1H5E 87/150 kV 1000xxxx B00 2018 02

CONDITIONS OF SUPPLY

At the nominal length required on each drum (depending on the cable destination) a tolerance of + 1% of the length

LOCAL SECTION G – Endesa Distribución Eléctrica

Tanto el diámetro nominal del conductor como el diámetro sobre el aislamiento deberán ajustarse al indicado en la tabla siguiente y, en cualquier caso, estarán comprendidos en los márgenes de tolerancias que se indican para garantizar la compatibilidad dimensional del cable con los accesorios (empalmes y terminales).

Valores de diámetros nominales y tolerancias del conductor y sobre aislamiento para garantizar la compatibilidad con los accesorios

Tensión U	Sección del conductor	Diámetro nominal del conductor	Tolerancias del diámetro del conductor	Diámetro nominal sobre aislamiento	Tolerancias del diámetro sobre aislamiento
45 kV	400 mm^2 Al	23,5 mm	23,2 – 23,9 mm	40,0 mm	39,4 – 41,0 mm
	800 mm^2 Al	34,0 mm	33,6 – 34,6 mm	50,5 mm	49,5 – 51,0 mm
66 kV	630 mm^2 Al	30,5 mm	30,1 – 30,9 mm	52,0 mm	51,5 – 53,0 mm
	1000 mm^2 Al	38,5 mm	38,0 – 38,9 mm	60,5 mm	60,0 – 61,5 mm
132 kV	630 mm^2 Al	30,5 mm	30,1 – 30,9 mm	65,5 mm	64,5 – 66,5 mm
	1200 mm^2 Al	43,5 mm	43,0 – 44,0 mm	79,0 mm	78,0 – 80,2 mm

Sobre la cubierta debe existir una capa extruida semiconductora que facilite la realización de los ensayos eléctricos.

Consideraciones frente al fuego

El cable será no propagador de la llama, conforme a la Norma UNE-EN 60332-1-2, requiriéndose para ello el ensayo y requerimientos descritos en esta norma.

Se comprobará mediante métodos espectrofotométricos que el contenido de metales pesados de la cubierta es inferior a 0,5 %

La clase mínima de reacción al fuego es Eca

Ensayos de tipo adicionales

Además de los ensayos de tipo incluidos en el cuerpo principal, se deberán realizar los siguientes ensayos con los requerimientos y métodos indicados en la norma UNE-211632-1:

- Ensayo de resistencia al desgarro del material de cubierta
- Ensayo especial de resistencia a la abrasión con ensayos eléctricos de la cubierta
- Ensayo de absorción de agua del material de cubierta
- Determinación del contenido de metales pesados en el material de la cubierta
- Ensayo de envejecimiento climático
- Ensayo de absorción de agua del aislamiento

Marcaje e Identificación del Cable

Sobre la cubierta del cable debe estar marcado y ser fácilmente legible lo siguiente:

- ENDESA KNE001.
- Nombre del fabricante,
- Tensión asignada U_0/U (Um) en kV,
- Material aislante,
- Sección (en mm^2) y material del conductor,
- + Tipo de pantalla (H: alambres, T: Tubo)
- Sección (en mm^2) de la pantalla,
- Al, (solo si el material de los alambres de la pantalla es Al),
- Año de fabricación (dos últimas cifras),
- Número de orden de fabricación.

Además, el metraje del cable irá marcado metro a metro en la cubierta.

El marcaje se debe realizar sobre la cubierta exterior por impresión en relieve sobre dos generatrices diametralmente opuestas. La distancia entre dos marcas consecutivas no deberá ser mayor a un metro y la altura mínima de los caracteres deberá ser de 4 mm.

Por ejemplo, un cable Type I, de 132 kV y 1200 mm^2 de sección de aluminio y con pantalla de 120 mm^2, fabricado en el año 2018 irá marcado de la siguiente manera:

Endesa KNE 001- Fabricante - 76/132 (145) kV - XLPE - 1x1200 Al + H120 - 18- Nº O.F.

Marcaje e Identificación de las Bobinas del Cable

Sobre la bobina del cable debe estar marcado lo siguiente:

- Destino de la bobina
- Número de pedido
- Número de la bobina
- Nombre del fabricante o marca.
- País de origen
- Código de designación del cable (según punto 5.11.1)
- Clase de reacción al fuego según la Norma EN 50575, apartado 4.1
- Año de fabricación (dos últimas cifras),
- Número de orden de fabricación,
- Longitud de cable en la bobina, en metros,
- Dirección de rotación de la bobina (con una flecha),
- Peso bruto y neto de la bobina.

ANNEX A - TECHNICAL CHECK-LIST EXAMPLE

Item	Description	Unit	Required	Offered
1	**GENERAL INFORMATION**			
1.1	Supplier	-	Info	
1.2	Factory	-	Info	
1.3	Location of factory	-	Info	
2	**MAIN FEATURES**			
2.1	Distribution Company and Country	-	Endesa Distribución Electrica. España	
2.2	Country Code	-	330038	
2.3	GS Type Code		GSCH010/014	
2.4	Nominal Voltage Uo/U (Umax)	[kV]	26/45(52)	
2.5	Type I or Type II	-	Type II	
2.6	Designation	-	Enel GSCH010 - 26/45(52) kV - XLPE - 1x800 Al +T76	
3	**CONDUCTOR**			
3.1	Material	-	Aluminium	
3.2	Nominal cross-section	[mm^2]	800	
3.3	Stranding Type	-	Compacted Class 2	
3.4	Minimum diameter of conductor	[mm]	33,6	
3.5	Maximum diameter of conductor	[mm]	34,6	
3.6	Number of wires of conductor	-	-	
3.7	Nominal diameter of wires	[mm]	-	
3.8	Conductor DC resistance at 20°C	[Ω/ km]	0,0367	
3.9	Watertightness measures	-	No	
3.10	Measures taken to reduce skin effect	-	No	
4	**CONDUCTOR SCREEN**			
4.1	Material		black semi-conductive cross-linked compound	
4.2	Nominal thickness	[mm]	1,5	
4.3	Minimum thickness	[mm]	1,2	
4.4	Volume resistivity	[Ω · m]	1000	
4.5	Calculated nominal electrical stress	[kV/mm]	-	
5	**INSULATION**			
5.1	Material	-	XLPE	
5.2	Nominal thickness	[mm]	7	
5.3	Minimum thickness	[mm]	6,3	

Item	Description	Unit	Required	Offered
5.4	Nominal inner diameter	[mm]	-	
5.5	Nominal outer diameter	[mm]	-	
5.6	Color	-	-	
5.7	Special additives	-	-	
6	**INSULATION SCREEN**			
6.1	Material		black semi-conductive cross-linked compound	
6.2	Nominal thickness	[mm]	1,5	
6.3	Minimum thickness	[mm]	1,2	
6.4	Volume resistivity	[Ω · m]	500	
6.5	Calculated nominal electrical stress	[kV/mm]	-	
7	**MANUFACTURING PROCESS FOR INSULATION SYSTEM**			
7.1	Type of extrusion		triple extrusion process	
7.2	Type of extrusion line		-	
7.3	Identification of extrusion line		-	
7.4	Curing means		-	
7.5	Cooling means		-	
8	**LONGITUDINAL WATER-TIGHNESS SWELLING TAPE**			
8.1	Material		semi-conductive material	
8.2	Nominal thickness	[mm]	-	
8.3	Nominal width	[mm]	-	
8.4	Overlapping	[%]	>10%	
9	**EARTH SCREEN (Type I cables)**			
9.1	Material of wires / tapes		N/A	
9.2	Number of wires		N/A	
9.3	Nominal wires diameter	[mm]	N/A	
9.4	Helix pitch	[mm]	N/A	
9.5	Number of tapes		N/A	
9.6	Thickness and width of tape	[mm]	N/A	
9.7	Nominal cross-section	[mm2]	N/A	
9.8	External diameter	[mm]	N/A	
9.9	DC resistance at 20°C	[Ω/ km]	N/A	
9.10	Semiconductive swellling tape material		N/A	
9.11	Semiconductive swellling tape thickness	[mm]	N/A	
9.12	Semiconductive swellling tape width	[mm]	N/A	
9.13	Aluminum foil bonded to oversheath nominal thickness	[mm]	N/A	

Item	Description	Unit	Required	Offered
10	**EARTH SCREEN (Type II cables)**			
10.1	Material		Aluminium	
10.2	Manufacturing process		Extruded	
10.3	Nominal thickness	[mm]	-	
10.4	Minimum thickness	[mm]	-	
10.5	Nominal cross-section	[mm2]	76	
10.6	External diameter	[mm]	-	
10.7	Maximum DC resistance at 20°C	[Ω/ km]	0,357	
11	**OUTER SHEATH**			
11.1	Sheat material		-	
11.2	Nominal thickness		3,8	
11.3	Minimum thickness		3,13	
11.4	Color		Black	
11.5	Material designation		-	
11.6	Semiconductive extruded skin thickness	[mm]	-	
11.7	Graphite coating applied		-	
11.8	Marking		Endesa KNE 001- *Fabricante* - 26/45 (52) kV - XLPE - 1x800 Al +T76 - 18- Nº O.F.	
12	**ADDITIONAL FEATURES**			
12.1	Nominal overall diameter of the cable	[mm]	-	
12.2	Minimum radius of curvature during laying	[mm]	-	
12.3	Minimum radius of curvature not tractioned	[mm]	-	
12.4	Total weight	[kg/m]	-	
12.5	Fire retardant (IEC 60332-1-2)		Yes	
12.6	Fire reaction Class (EN 50575 if apply)		Eca	

ANNEX B – GS TYPE CODES TABLE

GS Type Code	Rated Voltage	Conductor section	Conductor Material	XLPE Thickness	Cable Type	Screen Section Al (Cu)	I cc (0,5 s) estimated
GSCH010/001	220 kV	2500*	Al	21	II	363	41
GSCH010/002	220 kV	2000	Al	21	II	363	41
GSCH010/003	220 kV	1600	Al	21	II	363	41
GSCH010/004	220 kV	1000	Al	21	II	363	41
GSCH010/005	220 kV	800	Al	21	II	363	41
GSCH010/006	150 kV	1600	Al	16	II	242	31,5
GSCH010/007	150 kV	1000	Al	17	II	242	31,5
GSCH010/008	150 kV	630	Al	18	II	242	31,5
GSCH010/009	132 kV	1200	Al	16	II	242	31,5
GSCH010/010	132 kV	800	Al	16	II	242	31,5
GSCH010/011	132 kV	630	Al	16	II	242	31,5
GSCH010/012	69 kV	1000	Al	9	II	144	20
GSCH010/013	69 kV	630	Al	9	II	144	20
GSCH010/014	45 kV	800	Al	7	II	76	9,3
GSCH010/015	45 kV	400*	Al	7	II	76	9,3
GSCH010/016	150 kV	1600	Al	16	I	144 (95)	20
GSCH010/017	150 kV	1000	Al	17	I	144 (95)	20
GSCH010/018	150 kV	630	Al	18	I	144 (95)	20
GSCH010/019	132 kV	1200	Al	16	I	363 (240)	41
GSCH010/020	132 kV	1200	Al	16	I	182 (120)	23
GSCH010/021	132 kV	630	Al	16	I	182 (120)	23
GSCH010/022	69 kV	2000	Al	9	I	363 (240)	41
GSCH010/023	69 kV	1000	Al	9	I	144 (95)	20
GSCH010/024	69 kV	800	Al	9	I	363 (240)	41
GSCH010/025	45 kV	400*	Al	7	I	76 (50)	9,3
GSCH010/026	132 kV	630	Cu	16	I	242 (160)	31,5
GSCH010/027	69 kV	1200	Cu	9	I	363 (240)	41
GSCH010/028	69 kV	630	Cu	9	I	363 (240)	41
GSCH010/029	69 kV	2000	Cu	9	I	363 (240)	41
GSCH010/030	220 kV	1200	Cu	21	I	363 (240)	41
GSCH010/031	220 kV	2000	Cu	21	I	363 (240)	41
GSCH010/032	138 kV	1200	Cu	16	I	242 (160)	31,5
GSCH010/033	138 kV	1600	Cu	16	I	242 (160)	31,5
GSCH010/034	138 kV	2000	Cu	16	I	242 (160)	31,5
GSCH010/035	138 kV	400*	Al	16	I	242 (160)	31,5
GSCH010/036	138 kV	800	Al	16	I	242 (160)	31,5
GSCH010/037	138 kV	1000	Al	16	I	242 (160)	31,5
GSCH010/038	138 kV	1600	Al	16	I	242 (160)	31,5
GSCH010/039	138 kV	2000	Al	16	I	242 (160)	31,5

ANNEX C – Steady state ampacity estimated values for directly buried single circuit.

GS Type Code	Rated Voltage	Conductor	Solid bonding		Single point bonding	
			50 Hz (A)	60 Hz (A)	50 Hz (A)	60 Hz (A)
GSCH010/001	220 kV	2500* Al	830	764	1126	1091
GSCH010/002	220 kV	2000 Al	791	733	1047	1020
GSCH010/003	220 kV	1600 Al	742	692	948	928
GSCH010/004	220 kV	1000 Al	642	608	728	704
GSCH010/005	220 kV	800 Al	589	562	656	639
GSCH010/006	150 kV	1600 Al	772	716	947	923
GSCH010/007	150 kV	1000 Al	658	622	729	706
GSCH010/008	150 kV	630 Al	545	524	584	573
GSCH010/009	132 kV	1200 Al	700	658	826	810
GSCH010/010	132 kV	800 Al	601	572	657	641
GSCH010/011	132 kV	630 Al	544	523	584	573
GSCH010/012	69 kV	1000 Al	680	645	737	717
GSCH010/013	69 kV	630 Al	556	537	588	579
GSCH010/014	45 kV	800 Al	640	620	666	655
GSCH010/015	45 kV	400* Al	445	438	455	452
GSCH010/016	150 kV	1600 Al	812	757	957	934
GSCH010/017	150 kV	1000 Al	679	645	735	713
GSCH010/018	150 kV	630 Al	557	538	586	577
GSCH010/019	132 kV	1200 Al	659	620	811	797
GSCH010/020	132 kV	1200 Al	712	670	826	811
GSCH010/021	132 kV	630 Al	549	529	584	573
GSCH010/022	69 kV	2000 Al	758	702	1029	1002
GSCH010/023	69 kV	1000 Al	672	636	732	711
GSCH010/024	69 kV	800 Al	569	542	640	622
GSCH010/025	45 kV	400* Al	442	435	453	451
GSCH010/026	132 kV	630 Cu	644	608	715	691
GSCH010/027	69 kV	1200 Cu	734	679	992	965
GSCH010/028	69 kV	630 Cu	607	573	697	671
GSCH010/029	69 kV	2000 Cu	825	752	1218	1165
GSCH010/030	220 kV	1200 Cu	759	705	1006	980
GSCH010/031	220 kV	2000 Cu	857	783	1234	1183
GSCH010/032	138 kV	1200 Cu	794	730	1008	976
GSCH010/033	138 kV	1600 Cu	857	779	1143	1096
GSCH010/034	138 kV	2000 Cu	904	814	1246	1184
GSCH010/035	138 kV	400* Al	429	419	450	445
GSCH010/036	138 kV	800 Al	597	569	652	635
GSCH010/037	138 kV	1000 Al	653	617	724	700
GSCH010/038	138 kV	1600 Al	762	707	943	919
GSCH010/039	138 kV	2000 Al	817	751	1044	1011

Rev.00 19/11/2018		COMMON LIST												
GS Type Code	Distribution Company and Country	Country Code	Rated Voltage Uo/U(Umax) [kV]	Cross-section [mm^2]	Conductor material	Nominal insulation thickness [mm]	Minimum insulation thickness [mm]	Longitudinal watertightness (Yes/Not)	Cable type	Earth Screen material	Screen cross-section [mm2]	Aluminum tape minimum thickness [mm]	Sheath rated thickness [mm]	Sheath minimun thickness [mm]
GSCH010/009	EDE Spain	330056	76/132(145)	1200	Al	16	14,4	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/011	EDE Spain	330055	76/132(145)	630	Al	16	14,4	YES	Type II	Aluminium	242	-	3,5	2,88
GSCH010/012	EDE Spain	330054	36/66(72,5)	1000	Al	9	8,1	YES	Type II	Aluminium	144	-	4	3,3
GSCH010/013	EDE Spain	330053	36/66(72,5)	630	Al	9	8,1	YES	Type II	Aluminium	144	-	3,5	2,88
GSCH010/014	EDE Spain	330038	26/45(52)	800	Al	7	6,3	YES	Type II	Aluminium	76	-	3,8	3,13
GSCH010/015	EDE Spain	330057	26/45(52)	400*	Al	7	6,3	YES	Type II	Aluminium	76	-	3,5	2,88
GSCH010/020	EDE Spain	330052	76/132(145)	1200	Al	16	14,4	YES	Type I	Copper	120	0,1	4	3,3
GSCH010/021	EDE Spain	330050	76/132(145)	630	Al	16	14,4	YES	Type I	Copper	120	0,1	3,5	2,88
GSCH010/023	EDE Spain	330049	36/66(72,5)	1000	Al	9	8,1	YES	Type I	Copper	95	0,1	4	3,3
GSCH010/025	EDE Spain	330039	26/45(52)	400*	Al	7	6,3	YES	Type I	Copper	50	0,1	3,5	2,88
GSCH010/003	EDI Italy	330014	127/220(245)	1600	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/006	EDI Italy	330013	87/150(170)	1600	Al	16	14,4	YES	Type II	Aluminium	242	-	4,5	3,73
GSCH010/007	EDI Italy	330012	87/150(170)	1000	Al	17	15,3	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/008	EDI Italy	330011	87/150(170)	630	Al	18	16,2	YES	Type II	Aluminium	242	-	3,5	2,88
GSCH010/016	EDI Italy	330010	87/150(170)	1600	Al	16	14,4	YES	Type I	Copper	95	0,1	4,5	3,73
GSCH010/017	EDI Italy	330009	87/150(170)	1000	Al	17	15,3	YES	Type I	Copper	95	0,1	4	3,3
GSCH010/018	EDI Italy	330001	87/150(170)	630	Al	18	16,2	YES	Type I	Copper	95	0,1	3,5	2,88
GSCH010/009	Enel Argentina		76/132(145)	1200	Al	16	14,4	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/010	Enel Argentina		76/132(145)	800	Al	16	14,4	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/020	Enel Argentina		76/132(145)	1200	Al	16	14,4	YES	Type I	Copper	120	0,1	4	3,3
GSCH010/021	Enel Argentina		76/132(145)	630	Al	16	14,4	YES	Type I	Copper	120	0,1	3,5	2,88
GSCH010/026	Enel Argentina		76/132(145)	630	Cu	16	14,4	YES	Type I	Copper	160	0,1	3,5	2,88
GSCH010/009	Enel Brazil	T330089	80/138(145)	1200	Al	16	14,4	YES	Type II	Aluminium	242	-	4,5	3,73
GSCH010/010	Enel Brazil	T330095	80/138(145)	800	Al	16	14,4	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/011	Enel Brazil	T330101	80/138(145)	630	Al	16	14,4	YES	Type II	Aluminium	242	-	3,5	2,88
GSCH010/012	Enel Brazil	T330097	40/69(72,5)	1000	Al	9	8,1	YES	Type II	Aluminium	144	-	4	3,3
GSCH010/013	Enel Brazil	T330096	40/69(72,5)	630	Al	9	8,1	YES	Type II	Aluminium	144	-	3,5	2,88
GSCH010/020	Enel Brazil	T330088	80/138(145)	1200	Al	16	14,4	YES	Type I	Copper	120	0,1	4	3,3
GSCH010/023	Enel Brazil	T330094	40/69(72,5)	1000	Al	9	8,1	YES	Type I	Copper	95	0,1	4	3,3
GSCH010/001	Enel Chile		127/220(245)	2500*	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/002	Enel Chile		127/220(245)	2000	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/003	Enel Chile		127/220(245)	1600	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73

Rev.00 19/11/2018		COMMON LIST												
GS Type Code	Distribution Company and Country	Country Code	Rated Voltage Uo/U(Umax) [kV]	Cross-section [mm^2]	Conductor material	Nominal insulation thickness [mm]	Minimum insulation thickness [mm]	Longitudinal watertightness (Yes/Not)	Cable type	Earth Screen material	Screen cross-section [mm2]	Aluminum tape minimum thickness [mm]	Sheath rated thickness [mm]	Sheath minimun thickness [mm]
GSCH010/004	Enel Chile		127/220(245)	1000	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/009	Enel Chile		76/132(145)	1200	Al	16	14,4	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/011	Enel Chile		76/132(145)	630	Al	16	14,4	YES	Type II	Aluminium	242	-	3,5	2,88
GSCH010/020	Enel Chile		76/132(145)	1200	Al	16	14,4	YES	Type I	Copper	120	0,1	4	3,3
GSCH010/021	Enel Chile		76/132(145)	630	Al	16	14,4	YES	Type I	Copper	120	0,1	3,5	2,88
GSCH010/019	Enel Colombia		76/132(145)	1200	Al	16	14,4	YES	Type I	Copper	240	0,1	4	3,3
GSCH010/002	Enel Perú		127/220(245)	2000	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/005	Enel Perú		127/220(245)	800	Al	21	18,9	YES	Type II	Aluminium	363	-	4,5	3,73
GSCH010/022	Enel Perú		36/66(72,5)	2000	Al	9	8,1	YES	Type I	Copper	240	0,1	4,5	3,73
GSCH010/024	Enel Perú		36/66(72,5)	800	Al	9	8,1	YES	Type I	Copper	240	0,1	3,8	3,13
GSCH010/027	Enel Perú		36/66(72,5)	1200	Cu	9	8,1	YES	Type I	Copper	240	0,1	4	3,3
GSCH010/028	Enel Perú		36/66(72,5)	630	Cu	9	8,1	YES	Type I	Copper	240	0,1	3,5	2,88
GSCH010/029	Enel Perú		36/66(72,5)	2000	Cu	9	8,1	YES	Type I	Copper	240	0,1	4,5	3,73
GSCH010/030	Enel Perú		127/220(245)	1200	Cu	21	18,9	YES	Type I	Copper	240	0,1	4,5	3,73
GSCH010/031	Enel Perú		127/220(245)	2000	Cu	21	18,9	YES	Type I	Copper	240	0,1	4,5	3,73
GSCH010/006	Enel Romania	330001	87/150(170)	1600	Al	16	14,4	YES	Type II	Aluminium	242	-	4,5	3,73
GSCH010/007	Enel Romania	330009	87/150(170)	1000	Al	17	15,3	YES	Type II	Aluminium	242	-	4	3,3
GSCH010/008	Enel Romania	330010	87/150(170)	630	Al	18	16,2	YES	Type II	Aluminium	242	-	3,5	2,88
GSCH010/016	Enel Romania	330011	87/150(170)	1600	Al	16	14,4	YES	Type I	Copper	95	0,1	4,5	3,73
GSCH010/017	Enel Romania	330012	87/150(170)	1000	Al	17	15,3	YES	Type I	Copper	95	0,1	4	3,3
GSCH010/018	Enel Romania	330016	87/150(170)	630	Al	18	16,2	YES	Type I	Copper	95	0,1	3,5	2,88
GSCH010/020	Enel Brazil(EP)		80/138(145)	1200	Al	16	14,4	YES	Type I	Copper	120	0,2	4	3,3
GSCH010/021	Enel Brazil(EP)		80/138(145)	630	Al	16	14,4	YES	Type I	Copper	120	0,2	3,5	2,88
GSCH010/032	Enel Brazil(EP)		80/138(145)	1200	Cu	16	14,4	YES	Type I	Copper	160	0,2	4	3,3
GSCH010/033	Enel Brazil(EP)		80/138(145)	1600	Cu	16	14,4	YES	Type I	Copper	160	0,2	4,5	3,73
GSCH010/034	Enel Brazil(EP)		80/138(145)	2000	Cu	16	14,4	YES	Type I	Copper	160	0,2	4,5	3,73
GSCH010/035	Enel Brazil(EP)		80/138(145)	400	Al	16	14,4	YES	Type I	Copper	160	0,2	3,5	2,88
GSCH010/036	Enel Brazil(EP)		80/138(145)	800	Al	16	14,4	YES	Type I	Copper	160	0,2	3,8	3,13
GSCH010/037	Enel Brazil(EP)		80/138(145)	1000	Al	16	14,4	YES	Type I	Copper	160	0,2	3,8	3,13
GSCH010/038	Enel Brazil(EP)		80/138(145)	1600	Al	16	14,4	YES	Type I	Copper	160	0,2	4,5	3,73
GSCH010/039	Enel Brazil(EP)		80/138(145)	2000	Al	16	14,4	YES	Type I	Copper	160	0,2	4,5	3,73

* For any code where “Cable Type” is “Type I” the wires material is cooper, but it is also possible the use of aluminium wires. In that case the earth screen sections are those indicated in Table 7 as “Equivalent Al section”.

GS Type Code	Country Code	TAM Description
GSCH001/001		