HIGH CAPACITY BARE CONDUCTORS

Countries I&N	
Argentina	**Carlos Alberto Espinoza Gómez**
Brazil	**Romulo Alves Moreira Sales**
Chile	**Daniel Alejandro González Sarkis**
Colombia	**Juan Carlos Gómez Cubillos**
Italy	**Luca Giansante**
Peru	**Roberto Sanchez Vargas**
Romania	**Vasilica Obrejan**
Spain	**Juan González Lara**

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

Revision	Data	List of modifications
00	01/03/2018	First emission
01	15/04/2019	Addition of new sections of conductors. Renumbering of GS Type Codes

INDEX

1 SCOPE OF THE DOCUMENT

The aim of this document is to define the technical requirements for the different technologies of high capacity concentric stranded bare conductors to be used in the high voltage overhead lines of the Enel Group Distributions 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 Eletropaulo	*Brazil*
Enel Distribuição Ceará	*Brazil*
Enel Distribuição Rio	*Brazil*
Enel Distribuição Goiás	*Brazil*

The document also includes the tests to be satisfied by the supplier.

2 LIST OF COMPONENTS

The list of components includes the following types of technologies of high capacity bare conductors selected for the high voltage lines of Enel Group Distribution Companies:

GS Type	Type Technology	Material Core	Material Outside core wires
Type I	Aluminum Conductor PMC Core	Polymer Matrix Composite Core	Aluminum (fully annealed or thermal resistant) wires
Type II	Aluminum Conductor MMC Core	Metal Matrix Composite Core wires	Thermal resistance Aluminum Alloy wires
Type III	ACSS/TW	Zn95Al5 Coated Steel wires	Aluminum fully annealed trapezoidal wires
Type IV	GAP	Al Clad Steel Core wires	Thermal resistance Aluminum Alloy trapezoidal & round wires

These technologies can carry electricity at higher temperature than a conventional conductor keeping sag, then it can be increased their ampacity (they are known as HTLS conductors, High Temperature Low Sag). This characteristic makes of the High Capacity Conductors a very suitable alternative for repowering a line or for spans with special requirements. The Annex 1 attaches a table with a list of cross-sections of the different technologies which are suggested to cover the complete range for the different Enel Group Distribution Companies.

It is recommended a study for each project in order to confirm the chosen conductor cross section or to propose the most appropriate one in terms of technical and economical requirements. This type of study should consider the required ampacity, the ambient conditions (temperature, sun radiation, wind speed, etc.) and the characteristics from the line (actual towers, distances, etc.).

3 REFERENCE STANDARDS

- EN 50182 Conductors for overhead lines. Round wire concentric lay stranded conductors
- EN 61232 Aluminum-clad steel wires for electrical purposes (IEC 1232)
- EN 62004 Thermal-resistant aluminum alloy wire for overhead line conductor (IEC 62004)
- EN 50540 Conductors for overhead lines. Aluminum conductors steel supported (ACSS)
- EN 62420 Concentric lay stranded overhead electrical conductors containing one or more gap(s) (IEC 62420)
- EN 10244-2 Steel wire and wire products. Non-ferrous metallic coatings on steel wire. Zinc or zinc alloy coatings.
- ASTM B502: Standard Specification for Aluminum Clad Steel Core Wire for aluminum conductors
- ASTM B609: Standard specification for Aluminum 1350 wire, annealed and intermediate tempers, for electrical purposes
- ASTM B803: Standard specification for High_Strength Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core wire for aluminum and aluminum-alloy conductors, steel reinforced.
- ASTM B856: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors Steel Suported (ACSS)
- ASTM B857: Standard Specification for Shaped Wire Compact Concentric-Lay-Stranded Aluminum Conductors Steel Suported (ACSS/TW)
- ASTM B941 Standard Specification for Heat Resistant Aluminum-Zirconium Alloy Wire for Electrical Purposes
- ASTM B958 Standard draft specification for Extra-High_and Ultra-High Strength Zinc-5% Aluminum-Mischmetal Alloy-Coated Steel Core wire for aluminum and aluminum-alloy conductors, steel reinforced.
- ASTM B976: Standard Specification for Fiber Reinforced Aluminum Matrix Composite (AMC) Core Wire for Aluminum Conductors, Composite Reinforced (ACCR)
- ASTM B978: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Composite Reinforced (ACCR)
- ASTM B987 Standard Specification for Carbon Fiber Composite Cores
- IEC 60121 Recommendation for commercial annealed aluminum electrical conductor wire
- EN 50326 Conductors for overhead lines. Characteristics of greases
- IEC 60468 Method of measurement of resistivity of metallic materials

4 SERVICE CONDITIONS

The selected conductors have all of them an appropriate behaviour against pollution adverse conditions due to its technical characteristics.

In case of extreme conditions, it will be useful to analyse the site with each supplier in order to have a better estimation for the expected life of the conductor.

5 TECHNICAL CHARACTERISTICS

5.1 Conductors with composite core (PMC & MMC)

This chapter describes the aluminum conductors (annealed or thermo resistant) with composite core.

This composite core can be polymer matrix composite or metal matrix composite. Attached are the proposed technologies:

GS Type	Type Technology	Registered name	Material Core	Material Outside core wires
Type I	Aluminum Conductor PMC Core	ACCC	Carbon fiber in epoxi resin matrix protected by glass fiber	Aluminum fully annealed T wires
		ACPR-Lo Sag	Carbon fiber in epoxi resin matrix protected by aluminum	Thermo-resistant aluminum zirconium alloy Z or Z&T wires
		OHC-HV	Carbon fiber in epoxi resin matrix wires protected by aluminum	Thermo-resistant aluminum zirconium alloy round or T wires
Type II	Aluminum Conductor MMC Core	ACCR	Aluminum oxide fibers embedded in aluminum	Thermo-resistant aluminum zirconium alloy round or T wires

5.1.1 Aluminium Conductor Polymer matrix composite Core (GS Type I)

Note: Describes the materials included in the different proposed technologies (ACCC, ACPR-Lo Sag, OHV-HV)

5.1.1.1. Polymer Matrix Composite core

Core made of carbon fibers embedded in high-temperature epoxy resin matrix.

This core can be protected in different ways:

- Glass fibers to improve flexibility and toughness. It also prevents galvanic corrosion
- Aluminum, which prevents therm-oxidation and mechanic and chemical damage.

5.1.1.2. Annealed Aluminum Trapezoidal Wires

Outside core, wires are formed by fully annealed aluminum trapezoidal wires, aluminum AL0 or 1350-O, which keeps his characteristics at high temperature and also improves conductivity and fatigue resistance.

Reference Standard for the material: EN 50540[1] and/or ASTM B609[2].

The different layers of aluminum wires are twisted around the core composite alternatively in one direction and another such that the outer layer rotates clockwise.

5.1.1.3. Thermal resistance Aluminum Alloy Trapezoidal, Z-shape or round Wires

Outside core, wires are formed by Zirconium-Aluminum alloy. Zirconium confers a better mechanical behaviour at higher operating temperatures and prevents the aluminum from becoming annealed when operating at high temperatures.

Reference Standard for the material: IEC 62004 and/or ASTM B941.

The different layers of aluminum wires are twisted around the core alternatively in one direction and another such that the outer layer rotates clockwise.

5.1.2 Aluminium Conductor Metal matrix composite Core (GS Type II)

Note: It is described the only option included in the standard (ACCR)

5.1.2.1. Aluminum Matrix Composite Core Wires

The core is formed by round wires made of Aluminum oxide continuous fibers embedded in pure aluminum. It is a very high strength material with a very low thermal expansion coefficient.

[1] ¨Chapter 5.

[2] After stranding, the trapezoidal aluminum wires shall conform to the requirements of ASTM B609 except for the shape and the diameter tolerance.

5.1.2.2. Thermal resistance Aluminum Alloy Trapezoidal or round Wires

Outside core, wires are formed by Aluminum-Zirconium alloy. Zirconium confers a better mechanical behaviour at higher operating temperatures and prevents the aluminum from becoming annealed when operating at high temperatures.

Reference Standard for the material: IEC 62004 and/or ASTM B941.

The different layers of aluminum wires are twisted around the core alternatively in one direction and another such that the outer layer rotates clockwise.

5.2 Conductor ACSS/TW (GS Type III)

Reference Standard for the conductor: EN50540.

5.2.1 Aluminum-Zinc Coated Steel Core Wires[3]

The core is formed by round wires made of steel coated with Aluminum-Zinc alloy (95% Zinc-5% Aluminium), with an excellent mechanical behaviour at high temperature (steel type EHST).

Reference Standard for the material: EN 50540.

5.2.2 Annealed Aluminum Trapezoidal Wires

Outside core, trapezoidal wires are formed by fully annealed aluminum, type AL0 or 1350-O, which doesn't loose its properties at high temperatures and improves conductivity and fatigue resistance. Alternatively, it may be used round wires if it is more convenient.

Reference Standard for the material: EN 50540[4] and/or ASTM B609[5].

[3] ACCS conductor core can be designed with different materials. It has been chosen this one because of his good behavior at high temperature.

[4] ¨Chapter 5.

[5] After stranding, the trapezoidal aluminum wires shall conform to the requirements of ASTM B609 except for the shape and the diameter tolerance.

The different layers of aluminum wires are twisted around the core composite alternatively in one direction and another such that the outer layer rotates clockwise.

5.3 Conductor GAP GZTACSR (GS Type IV)

Reference Standard for the conductor: IEC 62420.

5.3.1 Aluminum cladded Steel Core Wires

The core is formed by round wires made of Aluminum steel coated, for a better behavior before corrosion (steel type 14EHSA).

Reference Standard for the material: EN50540 and/or ASTM B502.

5.3.2 Thermal resistance Aluminum alloy Trapezoidal wires

Outside core, wires are formed by Aluminum-Zirconium alloy (steel type AT3). Zirconium confers an excellent mechanical behaviour at higher operating temperatures and prevents the aluminum from becoming annealed when operating at high temperatures. It can be used steel type AT1, with less thermal resistance, then the conductor is known as GTACSR and it has an inferior maximum continuous operating temperature.

Reference Standard for the material: IEC 62004 and/or ASTM B941.

The first layer will be formed with trapezoidal wires, creating a gap which will be filled with high thermal resistance grease.

The other layers could be made of round or trapezoidal wires and they are twisted around the core alternatively in one direction and another such that the outer layer rotates clockwise

6 CONSTRUCTION CHARACTERISTICS

High capacity bare conductors work at very high temperatures, for that reason the design of accessories (specially clamps and dead-ends) must be prepared to withstand high temperatures.

On the other hand, these conductors sometimes are made of materials not used in conventional conductors, such as composites. The accessories must be specific for every particular material.

As a consequence, this type of conductor must be treated with all their accessories as a whole system.

7 TESTING

7.1 Type test

Type test shall be carried out over the conductor in order to verify its main characteristics, which depend on its design.

Each manufacturer shall make this test once to obtain the technical assessment for each conductor, and they should be repeated only when the design or manufacturing process has been modified.

7.2 Sample test

Sample test shall be carried out over final product samples to guarantee the quality of the conductors and compliance with the requirements of this standard.

7.2.1 Sample size

Sample test will carried out over in at least 10% of the reels, being tested all the wires.

If the supplier demonstrates ability to exceed the requirements, the sample can be reduced even until 10% of wires, although the size of the sample must assure the quality control of the batch.

7.3 Test description

See Annex 2.

8 SUPPLY REQUIREMENTS

8.1 Conductor packing

The conductor shall be properly protected against damage which may occur in ordinary handling and shipping.

The reels must support the conductor weight without deformations. The reel design shall respect the minimum bend radio and it will allow cranes to manipulate them.

The reel diameter will be at least 30 times the conductor diameter or 60 times the core diameter, the maximum of both values. In the case of composite core conductors, the reel diameter shall be at least 50 times the conductor or 150 times the core diameter, the maximum of both values.

For more sensitive conductors, such as fully annealed aluminum designs, it is recommended a special care: protection inside the reel, use of staves, paper between layers of conductors or similar…

Both ends of the conductor shall be secured to the spools and they will remain accessible, preventing accidental unrolling.

8.2 Conductor marking

Each reel shall be identified with a indelible and easily legible plate on the external face and in the inside, with the name of the final Enel Group distribution company. The plate shall include:

- Manufacturer name
- Conductor type
- Gross mass, net mass and tare
- Conductor length in metres
- Order number
- Reel number
- Serial number
- Manufacturing year
- Direction of rotation of the reel (with an arrow)
- Unwinding direction (if the reel is packed)

Note: The manufacturer shall use length measurement equipment with an accuracy of ± 1%

ANNEX 1 – COMPLETE LIST OF COMPONENTS WITH SUGGESTED CROSS-SECTIONS

- Data for complete conductor

GS Type Code	Standard	Type	Code Words	Size (mm^2)	Outside diameter (mm)	Mass (kg/km)	Rated strength (kN)	DC resistence (W/km)	Grease
GSCH007/001	N/A	Type I ACCC	ROVINJ	217,3	17,1	576	60,4	0,1487	No
GSCH007/002			LINNET	245,9	18,29	655	60,4	0,1319	
GSCH007/003			CASABLANCA	313,3	20,5	834	85,7	0,1024	
GSCH007/004			LISBON	349,6	21,79	931	85,7	0,0916	
GSCH007/005			DOVE	408,6	23,55	1083	101,7	0,0771	
GSCH007/006			BRUSSELS	473,3	25,15	1265	112	0,0666	
GSCH007/007			WARSAW	567,8	27,72	1519	130,2	0,0553	
GSCH007/008			DRAKE	590,6	28,14	1565	153,8	0,0536	
GSCH007/021		Type I ACPR Lo Sag	186-AT1/28	224,7	18	591	65,5	0,1506	No
GSCH007/022			289-AT1/38	339,5	21,8	898	94,9	0,102	
GSCH007/023			377-AT1/64	465,6	25,4	1219	139,4	0,0738	
GSCH007/024			549-AT1/64	548,1	27,7	1450	152,6	0,0611	
GSCH007/025			574-AT1/64	662,7	30,4	1769	170,8	0,0494	
GSCH007/041	N/A	Type II ACCR/TW	315-T20	191,2	18	552	64,5	0,17	No
GSCH007/042			HAWK 477TW	281	20	801	85,148	0,1134	
GSCH007/043			OSWEGO	390	23,6	1111	115,017	0,0814	

GS Type Code	Standard	Type	Code Words	Size (mm^2)	Outside diameter (mm)	Mass (kg/km)	Rated strength (kN)	DC resistence (W/km)	Grease
GSCH007/044			WABASH	449	25,2	1280	139,09	0,0705	
GSCH007/045			CURLEW 1053 TW	590	28,8	1672	158,706	0,0531	
GSCH007/061	EN 50540 ASTM B857	Type III ACSS/TW	ACSS/TW-198	197,9	16,82	686	64	0,161	No
GSCH007/062			ACSS/TW-280	280,9	20,04	974	88,2	0,1134	
GSCH007/063			ACSS/TW-364	364	22,62	1215	97,3	0,0853	
GSCH007/064			ACSS/TW-455	454,9	25,24	1519	119,8	0,683	
GSCH007/065			ACSS/TW-198	546	27,53	1822	143,8	0,0569	
GSCH007/081	IEC 62420	Type IV GAP GZTACSR	GZTACSR-186	186,47	16,8	634	60,55	0,1794	Yes
GSCH007/082			GZTACSR-293	292,95	22	1000	96,76	0,1146	
GSCH007/083			GZTACSR-385	384,5	25,24	1273	113,21	0,0856	
GSCH007/084			GZTACSR-462	462,1	27,6	1521	135,2	0,0711	
GSCH007/085			GZTACSR-553	553,25	30,47	1828	164,53	0,0595	

- Data for core and for envelope wires

			Conductor Core				Conductor Envelope			
GS Type Code	**Type**	**Code Words**	**Material**	**Description**	**Cross section (mm^2)**	**Standard**	**Material**	**Description**	**Cross section (mm^2)**	**Standard**
GSCH007/001	Type I ACCC	ROVINJ	Composite Core (PMC)	Hybrid carbon and glass fiber composite	28	N/A	Aluminium fully annealed	Trapezoidal wires, Aluminum AL0/1350-O	187,8	EN50540 ASTM B609
GSCH007/002		LINNET			28				218,1	
GSCH007/003		CASABLANCA			39,7				273,6	
GSCH007/004		LISBON			39,7				309,9	
GSCH007/005		DOVE			47,1				361,5	
GSCH007/006		BRUSSELS			51,9				421,4	
GSCH007/007		WARSAW			60,3				507,5	
GSCH007/008		DRAKE			71,3				519,7	
GSCH007/021	Type I ACPR Lo Sag	186-AT1/28		Carbon fiber composite, aluminum cladded	38,6	N/A	Thermal resistance Al Zr Alloy	Z-shape wires, Aluminum AT1	185,9	IEC 62004 ASTM B941
GSCH007/022		289-AT1/38			50,6				289	
GSCH007/023		377-AT1/64			88,7				376,8	
GSCH007/024		549-AT1/64			88,7				459,4	
GSCH007/025		574-AT1/64			88,7				574	
GSCH007/041	Type II ACCR/TW	315-T20	Composite Core (MMC)	Aluminium oxid fibers within pure Aluminium wires	31,5	ASTM B976	Thermal resistance Al Zr Alloy	Trapezoidal wires, Aluminum AT3	159,7	IEC 62004
GSCH007/042		HAWK 477TW			39				242	
GSCH007/043		OSWEGO			53				337	

			Conductor Core				Conductor Envelope			
GS Type Code	Type	Code Words	Material	Description	Cross section (mm^2)	Standard	Material	Description	Cross section (mm^2)	Standard
GSCH007/044		WABASH			62				387	ASTM B941
GSCH007/045		CURLEW 1053 TW			67				523	
GSCH007/061	Type III ACSS/TW	ACSS/TW-198	Al-Zn coated steel wires	EHST wires (Zn95Al5 coated steel)	27,7	EN50540	Aluminium fully annealed	Trapezoidal wires, Aluminum AL0/1350-O	170,2	EN50540 ASTM B609
GSCH007/062		ACSS/TW-280			39,3				241,6	
GSCH007/063		ACSS/TW-364			41,8				322,2	
GSCH007/064		ACSS/TW-455			52,2				402,7	
GSCH007/065		ACSS/TW-198			62,6				483,4	
GSCH007/081	Type IV GAP GZTACSR	GZTACSR-186	Al Clad Steel wires	14EHSA steel wires	23,1	EN50540 ASTM B502	Thermal resistance Al Zr Alloy	Trapezoidal & round wires , Aluminum AT3	163,37	IEC62004 ASTM B941
GSCH007/082		GZTACSR-293			37,17				255,78	
GSCH007/083		GZTACSR-385			40				244,5	
GSCH007/084		GZTACSR-462			47,81				414,3	
GSCH007/085		GZTACSR-553			58,07				495,18	

ANNEX 2 – TESTING LIST

- Test for GS Type I Conductors

GSCH007 Type I		Type Test	Sample Test	Standard/paragraph
Conductor	Surface condition	X	X	EN 50540 p. 6.4.1 & 5.3
	Conductor diameter	X	X	EN 50540 p. 6.4.2 & 5.4
	Lay inalterability	X	X	EN 50540 p. 6.4.3 & 5.2.4
	Lay ratio and direction ratio	X	X	EN 50540 p. 6.4.4 & 5.2
	Number and type wire	X	X	EN 50540 p. 6.4.5
	Aluminum cross section	X	X	EN 50540 p. 6.4.6
	Mass per unit length	X	X	EN 50540 p. 6.4.7
	Resistivity (DC)	X	-	EN 50540 p. 6.4.8 & IEC 60468
	Stress-strain curve	X	-	EN 50540 p. 6.4.9 & Annex A
	Tensile test	X	-	EN 50540 p. 6.4.10
	Laying test	X	-	EN 50540 p. 6.4.11 & Annex C
Aluminum Wires	Appearance	X	X	EN 50540 / ASTM B609*
	Diameter	X	X	EN 50540 / ASTM B609*
	Strength	X	X	EN 50540 / ASTM B609*
	Elongation	X	X	EN 50540 / ASTM B609*
	Resistivity	X	X	EN 50540 / ASTM B193*
	Cross-section	X	X	EN 50540*
	Wrapping test	X	X	ISO 7802*
	Welding	X	-	IEC 50182 p. 6.5.3*
Heat resistant Aluminum-Zr Wires	Condition	X	X	EN 62004 p. 7.3.1* / ASTM B941
	Diameter	X	X	EN 62004 p. 7.3.2* / ASTM B941
	Strength	X	X	EN 62004 p. 7.3.3* / ASTM B941
	Elongation	X	X	EN 62004 p. 7.3.4* / ASTM B941
	Resistivity	X	X	EN 62004 p. 7.3.5* / ASTM B941
	Thermal resistance	X	X	EN 62004 p. 7.3.6* / ASTM B941
	Wrapping test	X	X	EN 62004 p. 7.3.7 & ISO 7802* / ASTM B941
PMC Composite core	Appearance	X	X	ASTM B987 method a
	Dimension	X	X	ASTM B987 method b
	Tensile test	X	X	ASTM B987 method c
	Glass transition temperature test	X	X	ASTM B987 method d
	Density	X	-	ASTM B987 method e
	Bending test	X	-	ASTM B987 method f
	Dye penetrant testing after bending test	X	-	ASTM B987 method g
	Tensile test after bending test	X	-	ASTM B987 method h
	Heat exposure test	X	-	ASTM B987 method i
	Heat/stress test	X	-	ASTM B987 method j
	Galvanic protection barrier layer thickness	X	-	ASTM B987 method k

- Test for GS Type II Conductors

GSCH007 Type II		Type Test	Sample Test	Standard/paragraph
Conductor	Surface condition	X	X	EN 50540 p. 6.4.1 & 5.3
	Conductor diameter	X	X	EN 50540 p. 6.4.2 & 5.4
	Lay inalterability	X	X	EN 50540 p. 6.4.3 & 5.2.4
	Lay ratio and direction ratio	X	X	EN 50540 p. 6.4.4 & 5.2
	Number and type wire	X	X	EN 50540 p. 6.4.5
	Aluminum cross section	X	X	EN 50540 p. 6.4.6
	Mass per unit length	X	X	EN 50540 p. 6.4.7
	Resistivity (DC)	X	-	EN 50540 p. 6.4.8 & IEC 60468
	Stress-strain curve	X	-	EN 50540 p. 6.4.9 & Annex A
	Tensile test	X	-	EN 50540 p. 6.4.10
	Laying test	X	-	EN 50540 p. 6.4.11 & Annex C
Heat resistant Aluminum-Zr Wires	Condition	X	X	EN 62004 p. 7.3.1 / ASTM B941
	Diameter	X	X	EN 62004 p. 7.3.2 / ASTM B941
	Strength	X	X	EN 62004 p. 7.3.3 / ASTM B941
	Elongation	X	X	EN 62004 p. 7.3.4 / ASTM B941
	Resistivity	X	X	EN 62004 p. 7.3.5 / ASTM B941
	Thermal resistance	X	X	EN 62004 p. 7.3.6 / ASTM B941
	Wrapping test	X	X	EN 62004 p. 7.3.7 & ISO 7802 / ASTM B941
MMC Composite core	Appearance	X	X	ASTM B976
	Dimension	X	X	ASTM B976
	Mass per unit length	X	X	ASTM B976
	Strength	X	X	ASTM B976

- Test for GS Type III Conductors

GSCH007 Type III		Type Test	Sample Test	Standard/paragraph
Conductor	Surface condition	X	X	EN 50540 p. 6.4.1 & 5.3
	Conductor diameter	X	X	EN 50540 p. 6.4.2 & 5.4
	Lay inalterability	X	X	EN 50540 p. 6.4.3 & 5.2.4
	Lay ratio and direction ratio	X	X	EN 50540 p. 6.4.4 & 5.2
	Number and type wire	X	X	EN 50540 p. 6.4.5
	Aluminum cross section	X	X	EN 50540 p. 6.4.6
	Mass per unit length	X	X	EN 50540 p. 6.4.7
	Resistivity (DC)	X	-	EN 50540 p. 6.4.8 & IEC 60468
	Stress-strain curve	X	-	EN 50540 p. 6.4.9 & Annex A
	Tensile test	X	-	EN 50540 p. 6.4.10
	Laying test	X	-	EN 50540 p. 6.4.11 & Annex C
Aluminum Wires	Appearance	X	X	EN 50540 / ASTM B609
	Diameter	X	X	EN 50540 / ASTM B609
	Strength	X	X	EN 50540 / ASTM B609
	Elongation	X	X	EN 50540 / ASTM B609
	Resistivity	X	X	EN 50540 / ASTM B193
	Cross-section	X	X	EN 50540
	Wrapping test	X	X	ISO 7802
	Welding	X	-	IEC 50182 p. 6.5.3
Aluminum -Zinc Coated Steel Wires	Diameter	X	X	EN 50540 p.6.5.2
	Strength	X	X	EN 50540 p.6.5.2
	Elongation or torsion	X	X	EN 50540 p.6.5.2
	Zinc mass	X	X	EN 50540 p.6.5.2
	Zinc immersion test	X	X	EN 50540 p.6.5.2
	Zinc coating adhesion test	X	X	EN 50540 p.6.5.2

- Test for GS Type IV Conductors

GSCH007 Type IV		Type Test	Sample Test	Standard/paragraph
Conductor	Surface condition	X	X	EN 50540 p. 6.4.1 & 5.3
	Conductor diameter	X	X	EN 50540 p. 6.4.2 & 5.4
	Lay inalterability	X	X	EN 50540 p. 6.4.3 & 5.2.4
	Lay ratio and direction ratio	X	X	EN 50540 p. 6.4.4 & 5.2
	Number and type wire	X	X	EN 50540 p. 6.4.5
	Aluminum cross section	X	X	EN 50540 p. 6.4.6
	Mass per unit length	X	X	EN 50540 p. 6.4.7
	Resistivity (DC)	X	-	EN 50540 p. 6.4.8 & IEC 60468
	Stress-strain curve	X	-	EN 50540 p. 6.4.9 & Annex A
	Tensile test	X	-	EN 50540 p. 6.4.10
	Laying test	X	-	EN 50540 p. 6.4.11 & Annex C
	Gaps	X	-	EN 62420 p. 6.2.3
	Creep curve	X	-	EN 62420 p. 6.2.6
Heat resistant Aluminum-Zr Wires	Condition	X	X	EN 62004 p. 7.3.1 / ASTM B941
	Diameter	X	X	EN 62004 p. 7.3.2 / ASTM B941
	Strength	X	X	EN 62004 p. 7.3.3 / ASTM B941
	Elongation	X	X	EN 62004 p. 7.3.4 / ASTM B941
	Resistivity	X	X	EN 62004 p. 7.3.5 / ASTM B941
	Thermal resistance	X	X	EN 62004 p. 7.3.6 / ASTM B941
	Wrapping test	X	X	EN 62004 p. 7.3.7 & ISO 7802 / ASTM B941
Aluminum Cladded Steel Wires	Condition	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.2 & 4.2
	Diameter	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.2 & 4.4
	Strength	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.1
	Elongation	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.2
	Torsion	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.3
	Aluminum thicknes	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.4
	Resistivity	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.5
	Tensile test at 1% elongation	X	X	EN 50540 p.6.5.2 & EN 61232 p. 6.3.6

ANNEX 3- OPERATING TEMPERATURES AND AMPACITY RELATED

Maximum permissible temperatures

°C	ACCC	ACPR Lo-Sag	ACCR/TW	ACSS/TW	GAP GZTACSR
MAXIMUM CONTINUOUS OPERATING TEMPERATURE	180	150	210	250	210
MAXIMUM EMERGENCY TEMPERATURE	200	180	240		240

Ampacity at usual and maximum operating temperature:

GS Type Code	Type	Size (mm²)	Code Words	Ampacity @ usual operation T (75°C)	Max. Cont T	Ampacity @ T max cont
GSCH007/001	ACCC	217,3	ROVINJ	448	180	880
GSCH007/002	ACCC	245,9	LINNET	602	180	1014
GSCH007/003	ACCC	313,3	CASABLANCA	564	180	1120
GSCH007/004	ACCC	349,6	LISBON	611	180	1226
GSCH007/005	ACCC	408,6	DOVE	826	180	1410
GSCH007/006	ACCC	473,3	BRUSSELS	734	180	1479
GSCH007/007	ACCC	567,8	WARSAW	824	180	1673
GSCH007/008	ACCC	590,6	DRAKE	1036	180	1786
GSCH007/021	ACPR-Lo Sag	224,7	186-AT1/28	450	150	820
GSCH007/022	ACPR-Lo Sag	339,5	289-AT1/38	540	150	1040
GSCH007/023	ACPR-Lo Sag	465,6	377-AT1/64	658	150	1270
GSCH007/024	ACPR-Lo Sag	548,1	549-AT1/64	750	150	1430
GSCH007/025	ACPR-Lo Sag	662,7	574-AT1/64	875	150	1625
GSCH007/041	ACCR/TW	191,2	315-T20	422	210	907
GSCH007/042	ACCR/TW	281	HAWK 477TW	530	210	1148
GSCH007/043	ACCR/TW	390	OSWEGO	650	210	1427
GSCH007/044	ACCR/TW	449	WABASH	709	210	1564
GSCH007/045	ACCR/TW	590	CURLEW 1053 TW	841	210	1881
GSCH007/081	GAP GZTACSR	186,47	G(Z)TACSR-186	440	210	860
GSCH007/082	GAP GZTACSR	292,95	G(Z)TACSR-293	540	210	1180
GSCH007/083	GAP GZTACSR	384,5	G(Z)TACSR-385	640	210	1420
GSCH007/084	GAP GZTACSR	462,1	G(Z)TACSR-462	720	210	1610
GSCH007/085	GAP GZTACSR	553,25	G(Z)TACSR-553	800	210	1750

Conditions: 40 °C ambient temperature, wind 0,61m/s, elevation 0m, sun radiation 1033W/m², emissivity and absorption, 0,5

Rev.00 04/04/2019		COMMON LIST							
GS Type Code	**Distribution Company and Country**	**Country Code**	**Type**	**Code Words**	**Outside diameter (mm)**	**Mass (kg/Km)**	**DC Resistance (ohm/km)**	**Direction of lay of external layer**	**Grease (Y/N)**
GSCH007/002	Enel Rio- Brazil	T310072	ACCC	LINNET	18,29	655	0,1319	Right (Z)	No
GSCH007/004	Endesa-España	310008	ACCC	LISBON	21,79	931	0,0916	Right (Z)	No