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Overhead line conductors

IBERDROLA

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Overhead line conductors

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CONTROL CHANGES

Rev.	Date	Summary of changes/Reason for changes	Modified pages
1	February 2017	Update of SPEN references – amendments for UK only	7
		Removal of 35mm^2 flexible copper from copper conductor table A.2.5 to flexible conductor table A.2.6 – amendments for UK only	20
		Inclusion of flexible aluminium conductors – amendments for UK only	21, 27 & 29
		Removal of reference to BS 215 Part 1 – amendments for UK only	28
		Errata correction in table A.1.2 for i-DE regarding the Strand Diameter – Steel, in conductor 242-AL1/39-ST1A	13
2	September 2018	Change from Elektro to Neoenergia sections Integrated UIL into AVANGRID sections	Specific pages in main body and annexes of AVANGRID and Neoenergia
		Inclusion of note regarding manufacters inspection - All the countries	10
		Annexes structure has been reorganized to coincide with INS official template	12-46
3	January 2020	Soft-Drawn copper conductors included in the INS	All
		Revised Avangrid Annex A3 and Annex D3 to include all currently existing Avangrid bare overhead line conductor codes	Annex A3 and Annex D3
		Two new AAAC conductors codes (AMES, ANAHEIM)included in Neoenergia Annex A4	Table A.4.2
		Logo and company name changed from IBDE to i-DE	All
4	May 2021	Insertion of Neoenergia Distribuição Brasília as new Neoenergia Company	Specific pages for Neoenergia
		Copper clad steel conductors included in the INS	All
		Insertion of Section 4.4 Sustainability Requirements	10
		Included Standardized wording in Section 10	11
		Revised Neoenergia Annex A4 and Annex D4 to include all currently existing Neoenergia bare overhead line conductor codes	Annex A4 and Annex D4
		Section D2.4 included for SPEN	Annex D2

5	October 2022	Update i-DE & SPEN referenced documents	References
		Changed data for one conductor in table A.1.2 and A.1.3. Change in section D1.3, requirement about QR or data matrix included.	Annex A1 and D1 i-DE
		Update example of AL5 EHC Replace AAAC Table Update Copper Conductors Table	Annex A2 SPEN
		General updates	Annex D2 SPEN
		Revised reel lengths and reel designations (6 MID's)	Annex A3 Avangrid
		Inserted new conductors in table A.4.1 and A.4.2 (2 in total)	Annex A4 Neoenergia
6	September 2023	General updates for SPEN Removal of AAC Conductor section A.2.2	Annex A2 and D2 20
		General updates for Avangrid	Annex A3
		Insertion of new conductors for Neoenergia	Annex A4

CONTENTS

1. SCOPE

This Specification details the characteristics and test requirements for the following overhead line stranded conductors types: Aluminium Conductor Steel Reinforced (ACSR), All Aluminum Conductor (AAC), All Aluminium Alloy Conductor (AAAC), Aluminum Conductor Steel Supported (ACSS), Compacted Aluminium Conductor Steel Reinforced (CACSR), Aluminium Conductor Aluminium Alloy Reinforced (ACAR), Aluminium Alloy Conductor Steel Reinforced (AACSR), Hard Drawn Copper conductors (HDC), Medium-Hard Drawn Copper conductors (MHD), Soft-Drawn Copper conductors and Copper Clad Steel Conductors intended to operate on the Iberdrola Networks for overhead line networks.

Note: Aerial Bundled Conductors (ABC) are not included in this specification (see INS 56.36.02 for ABC).

For the purposes of this specification, the term Iberdrola Networks, refers to Iberdrola Distribución Eléctrica (i-DE), SP Energy Networks (SPEN), Central Maine Power Company, New York Electric & Gas, Rochester Gas and Electric and The United Illuminating Company (AVANGRID) and Coelba, Cosern, Elektro, Pernambuco and Neoenergia Distribuição Brasília (NEOENERGIA).

Where particular requirements are specific to i-DE, SPEN, AVANGRID or NEOENERGIA then the details of these requirements will be clarified in the corresponding ANNEX(es) in this specification.

The Figures given in this standard do not presuppose design.

2. REFERENCES

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. In case of a discrepancy between any of the listed reference standards and the INS-Standard, the INS standard shall take precedence. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

For i-DE and SPEN:

- EN 50182 Conductors for overhead lines – round wire concentric lay stranded conductors.
- EN 50189 Conductors for overhead lines – zinc coated steel wires.
- EN 61232 Aluminium-clad steel wires for electrical purposes
- EN 60889 Hard drawn aluminium wire for electrical purposes.
- IEC 61089 Round wire concentric lay overhead electrical stranded conductors.
- IEC 62641 Conductors for overhead lines – Aluminium and aluminium alloy wires for concentric lay stranded conductors
- IEC 61394 Overhead lines - Requirements for greases for aluminium, aluminium alloy and steel bare conductors

For i-DE

- UNE 21044: Planes de muestreo y criterios de aceptación y rechazo en la recepción de cables desnudos para conductores de líneas eléctricas aéreas.
- UNE 21045: Bobinas de madera destinadas a cables desnudos para líneas eléctricas aéreas.

- UNE 21162: Bobinas metálicas destinadas a conductores y cables de tierra para líneas eléctricas aéreas.

For SPEN

- BS 6485 PVC-Covered Conductors for Overhead Power Lines
- BS 6231 Specification for PVC-insulated cables for switchgear and control gear wiring
- BS 7884 Specification for copper and copper-cadmium stranded conductors for overhead electric traction and power transmission systems
- IEC 60228 Conductors of Insulated Cables
- ENA ER L 38 Overhead Line Conductors – Protection Against Corrosion By The Application of Anti-Corrosion Grease During Manufacture.

For AVANGRID:

- ASTM A90: Standard Test Method for Weight (Mass) of Coating on Iron or Steel Articles with Zinc or Zinc-Alloy Coatings.
- ASTM A239: Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
- ASTM A363: Standard Specification for Zinc-Coated (Galvanized) Overhead Ground Wire Strand
- ASTM B2: Standard Specification for Medium-Hard-Drawn Copper Wire
- ASTM B3: Standard Specification for Soft or Annealed Copper Wire
- ASTM B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- ASTM B230: Standard Specification for Aluminium 1350-H19 Wire.
- ASTM B231: Standard Specification for Concentric-Lay-Stranded Aluminium 1350 Conductors.
- ASTM B232: Standard Specification for Concentric-Lay-Stranded Aluminium Conductors, Coated-Steel Reinforced (ACSR).
- ASTM B341: Standard Specification for Aluminium-Coated (Aluminized) Steel Core Wire for Aluminium Conductors, Steel Reinforced (ACSR).
- ASTM B398: Standard Specification for Aluminium-Alloy 6201-T81 Wire for Electrical Purposes.
- ASTM B399: Standard Specification for Concentric-Lay-Stranded Aluminium-Alloy 6201-T81 Conductors.
- ASTM B498: Standard Specification for Zinc-Coated (Galvanized) Steel Core Wire for use in Overhead Electrical Conductors.
- ASTM B500: Standard Specification for Metallic Coated Stranded Steel Core for Use in Overhead Electrical Conductors.
- ASTM B524: Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Aluminum-Alloy Reinforced (ACAR, 1350/6201)
- ASTM B609: Standard Specification for Aluminium 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes.

- ASTM B802: Standard Specification for Zinc-5% Aluminium Mischmetal Alloy-Coated Steel Core Wire for Aluminium Conductors, Steel Reinforced (ACSR).
- ASTM B803: Standard Specification for High-Strength Zinc-5% Aluminium Mischmetal Alloy-Coated Steel Core Wire for Aluminium and Aluminium-Alloy Conductors, Steel Reinforced.
- ASTM B856 Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated Steel Supported (ACSS)
- NEMA WC26: Wire and Cable Packaging.

For NEOENERGIA

- ABNT NBR 5111: Fios de cobre nus, de seção circular, para fins elétricos (Round bare Copper wires for electrical purposes)
- ABNT NBR 5118: Fios de alumínio 1350 nus, de seção circular, para fins elétricos (Aluminum 1350 wire for electrical purposes)
- ABNT NBR 5285: Fios de liga alumínio-magnésio-silício, têmpera T81, nus, de seção circular, para fins elétricos (Aluminum-magnesium-silicon alloy wire for electrical purposes)
- ABNT NBR 6236: Madeira para carretéis para fios, cordoalhas e cabos (Wood for reels of wires, ropes and cables)
- ABNT NBR 6524: Fios e cabos de cobre duro e meio duro com ou sem cobertura protetora para instalações aéreas (Hard-drawn and medium-hard-drawn copper wires and cables with or without outer covering for overhead installations)
- ABNT NBR 6756: Fios de aço zincados para alma de cabos de alumínio e alumínio-liga (Zinc-coated steel wires for aluminum and aluminum alloy conductors)
- ABNT NBR 6810: Fios e cabos elétricos – Tração à ruptura em componentes metálicos (Electric wires and cables - Traction to rupture in metal components)
- ABNT NBR 6815: Fios e cabos elétricos - Ensaio de determinação da resistividade em componentes metálicos
- ABNT NBR 7270: Cabos de alumínio nus com alma de aço zincado para linhas aéreas – Especificação (Bare aluminum cables, zinc coated steel-reinforced, for overhead lines – Specification)
- ABNT NBR 7271: Cabos de alumínio nus para linhas aéreas (Bare aluminum cables, for overhead lines)
- ABNT NBR 7273: Condutor elétrico de alumínio: Retirada e preparo de corpo de prova para ensaio de tipo (Aluminum electrical conductor - Removal and preparation of specimen for type test)
- ABNT NBR 7310: Armazenamento, transporte e utilização de bobinas com fios, cabos ou cordoalhas de aço (Storage , transportation and use of reels for wires, cables and winding zinc coated steel wires ropes)
- ABNT NBR 8120: Fios de aço revestidos de cobre, nus, para fins elétricos – Especificação
- ABNT NBR 8121: Cabos de fios de aço revestidos de cobre, nus, para fins elétricos – Especificação

- ABNT NBR 10298: Cabos de liga de alumínio-magnésio-silício, nus, para linhas aéreas – Especificação (Bare aluminum-magnesium-silicon alloy cable for overhead lines – Specification)
- ABNT NBR 10841: Cabos de Alumínio reforçados por fios de aço revestidos de alumínio para linhas aéreas - Especificação
- ABNT NBR 11137: Carretel de madeira para acondicionamento de fios e cabos elétricos - Dimensões e estruturas – Padronização (Wooden reel for widing wires and cables - Dimensions and structures)
- ABNT NBR 15957: Fios de aço revestidos de alumínio, para alma e reforço de cabos de alumínio – Especificação
- ASTM B230: Standard Specification for aluminium 1350-H19 Wire

3. TERMS AND DEFINITIONS

Iberdrola Networks refers to i-DE, SPEN, AVANGRID and NEOENERGIA

i-DE:	i-DE, Redes Eléctricas Inteligentes
SPEN:	Scottish Power Energy Networks
AVANGRID:	AVANGRID-USA Operating Companies: Central Maine Power Company, New York Electric & Gas, Rochester Gas and Electric, and The United Illuminating Company
NEO:	Neoenergia
HD:	Harmonization Document
UNE:	Una Norma Española
IEC:	International Electrotechnical Commission
ENA:	Energy Networks Association
IEEE:	Institute of Electrical and Electronics Engineers
AEIC:	Association of Edison Illuminating Companies
NEMA:	National Electrical Manufacturers Association
ANSI:	American National Standards Institute
ASTM:	American Society for Testing and Materials
ISO:	International Organization for Standardization
ACSR:	Aluminium Conductor Steel Reinforced
ACSS:	Aluminum Conductors, Steel Supported
CACSR	Compacted Aluminium Conductor Steel Reinforced
AAC:	All Aluminium Conductor
AAAC:	All Aluminium Alloy Conductor
HDC	Hard Drawn Copper conductors
OHL:	Overhead Lines
ABNT:	Associação Brasileira de Normas Técnicas

4. REQUIREMENTS

4.1 Identification and Dimensions

The particular characteristics of each conductor type are discussed in Annex A for each Iberdrola Networks companies. However, common characteristics are generally described in this section.

4.2 Design and Manufacture

Conductor rating and manufacture design shall be according to specific requirements described in ANNEX D.

4.2.1 Rated Temperature

The temperature value shall be according to national regulations.

4.2.2 Stress-Strain Data

The Supplier shall provide the stress-strain coefficients of polynomial equations and creep data of the conductor supplied. This data will be used to improve calculations and sag optimisation.

4.2.3 Materials

All materials used in this specification for OHL are steel, aluminium, aluminium alloy, zinc (coating) and copper. The maximum resistivity of Aluminium-alloy at 20ºC can be improved at specific project requirements. All requirements are listed in ANNEX D.

4.2.4 Stranded Conductors

The number of layers, direction of external lay and strand ratios can vary with the requirements of each company (See ANNEX D).

4.3 Identification and Marking

Requirements are listed in ANNEX D.

4.4 Sustainability Requirements

The conductor shall not contain harmful, dangerous or environmentally unacceptable quantities of volatile hydrocarbons or heavy metals.

The design and construction of the conductor shall allow easy separation and recovery of constituents for recycling or treatment at the end of its useful life. The manufacturer shall provide information regarding re-use, recycling, recovery and disposal of the elements of conductor at the end of its life.

5. TESTING

Requirements are listed in ANNEX D.

6. DESIGNATION AND CODING

Designations for each conductor type are listed in ANNEX A: Ratings, Designation and Codes.

7. TRANSPORT, PACKING, STORAGE AND INSTALLATION

Special conditions for transport, packing, storage, handling and installation are indicated in ANNEX D.

8. HEALTH & SAFETY

The Supplier shall ensure that conductors are designed, manufactured, packaged and delivered safely and fully comply with the statutory Health & Safety requirements (if any) particular to i-DE, SPEN, AVANGRID and NEOENERGIA depending on where the product will be installed. If there are any, the different Health & Safety requirements applicable to these parts of Iberdrola Networks, they will be detailed in ANNEX F.

9. DOCUMENTATION FOR EACH DELIVERY

All the documentation shall be issued in Spanish (i-DE) or English language (SPEN or AVANGRID). Documentation in additional languages may be requested to allow understanding of the documentation by other parties as required.

The manufacturer shall accommodate the inspection of the cables by the IBERDROLA Networks Engineer, both during and following manufacture, if requested.

10. INFLUENCE OF THE PRODUCT ON THE ENVIRONMENT

The Tenderer shall provide evidence at the time of tender that they are certified to the environmental management system BS EN ISO 14001 or comparable environmental management system for the products tendered for as detailed in this specification.

Iberdrola has a vision of being a sustainable business and embedding the principles of sustainability in its decision making, with the targets shown in the table below.

Year	Carbon & Energy Reduction	Sustainable Resource Use	Water Efficiency & Protection
2050	Carbon neutral*	Zero waste	-50% water use*

*based on 2013/14 values.

Additionally, SPEN, Avangrid Networks and Neoenergia have set further sustainability interim targets:

SPEN:

Year	Carbon & Energy Reduction	Sustainable Resource Use	Water Efficiency & Protection
2023	-15% carbon footprint*	Divert 95% of waste from landfill	-10% water use*
2030	-80% carbon footprint*	100% waste reused or recycled	-25% water use*

*based on 2013/14 values.

Avangrid Networks:

Year	Sustainability Target
2020	Reduce emissions intensity by 25%
2035	Carbon Neutral

Neoenergia:

Year	Sustainability Target
2030	Reduce emissions intensity by 50%***
2050	Carbon Neutral

***This is related to Energy Generation.

Iberdrola's ability to meet these targets is dependent upon the environmental impact of its supply chain. To assist Iberdrola in meeting these targets, at the time of tender the Tenderer shall provide the following information:

- Provide a detailed breakdown of the materials used in each item and give evidence how material use has been optimised in each item.
- Provide details of the transportation and packaging arrangements for each item, and commit to optimising these, reducing the amount of packaging and the return of packaging for reuse over the contract period.
- Provide details of the end of life requirements for individual components and component packaging, including any circular economy practices and sustainable resource management. This information shall also be included with the delivered item.
- Provide details on the embodied carbon Provide details on the embodied carbon (in $kgCO_2e$ or $tonneCO_2e$), including the amount of energy used to manufacture each item, expressed in kWh, details of what percentage of the energy used is from renewable sources and details of carbon intensity in the country of manufacture, if known.
- Provide accurate environmental data in relation to each item e.g. environmental product declaration.
- Provide evidence of how they have been delivering sustainability and reducing carbon emissions over the last 3 years.

Despite the requirement to optimise transportation and packaging arrangements, the Tenderer shall ensure that each item is suitably packaged and protected to maintain the product and packaging as "fit for service" prior to use. All packaging shall be sufficiently durable giving regard to the function, reasonable use and contents of the packaging.

If the above information requested is not available, the Tenderer shall commit to developing mechanisms to provide this information within the first year of the contract period. If the Tenderer is unable to provide this information within the first year, then the Tenderer shall state the length of time required. Acceptance of the proposed timeline is at the discretion of Iberdrola. Milestones shall be set before the commencement of the contract award and progress checked through quarterly business review meetings. Tenderers with the mechanisms described in this section already in place shall be preferred.

11. QUALIFICATION AND ACCEPTANCE

The following sections give general rules for qualification and acceptance of suppliers.

11.1 Qualification

In general, the qualification of suppliers and products will be carried out according to Iberdrola Networks requirements.

The qualification process shall include performing the tests and inspections specified in Section 5 of this document. Conductor shall not be accepted until all Type Testing is completed.

Iberdrola Networks, reserves the right to repeat certain tests previously performed by the supplier or in the process of obtaining quality standards.

Manufacturers shall operate a fully documented quality assurance system and shall provide details of this system on request.

11.2 Acceptance

Acceptance criteria may vary according to the requirements of Iberdrola Networks, based on the quality management system implemented at the factory and the relationship with the supplier in respect to the product (experience, quality agreements, etc.). In principle, the tests specified in section 5 above shall be performed.

12. ANNEXES

ANNEX A: RATINGS, DESIGNATION AND CODES
- ANNEX A1: i-DE
- ANNEX A2: SPEN
- ANNEX A3: AVANGRID
- ANNEX A4: NEOENERGIA

ANNEX B: INTERFACES AND COMPATIBILITY
Not applicable (N/A).

ANNEX C: REQUIREMENTS FOR AUXILIARY AND CONTROL CIRCUIT COMPONENTS
Not applicable (N/A).

ANNEX D: ADDITIONAL CHARACTERISTICS AND TESTS
- ANNEX D1: i-DE
- ANNEX D2: SPEN
- ANNEX D3: AVANGRID
- ANNEX D4: NEOENERGIA

ANNEX E: INFORMATION TO BE PROVIDED BY THE SUPPLIER

ANNEX F: HEALTH AND SAFETY

ANNEX A: RATINGS, DESIGNATION AND CODES

ANNEX A1: i-DE

Meaning of the letters that make up the nomination:

Table A.1.1: Designation of Cable

Designation	Description
40/63/.../800	Conductor Section (Number), Section in mm² of Aluminium equivalent
AL*x* (Aluminium) / *yz*SA (Steel Aluminium-clad)	Conductor Material: *Aluminium*: *x* means Al type *Steel*: *y* means aluminium grade(A or B), *z* means aluminium-clad (20, 27, 30 or 40)
7/11/.../101	Core Section (if composed), (Number), Section in mm² of Steel
ST*yz* (Galvanized coating)	Core Material (if composed): *Steel*: *y* means steel grade (1 to 6) *z* means galvanized coating class (A to E)

Example of designation:

28-AL1:	Aluminium strands type AL1 (Hard-drawn Aluminium) conductor section 27.8 mm² rounded 28 mm²
279-AL2:	Aluminium strands type AL2 (Aluminium Alloy type 2) conductor section 279.3 mm² rounded 278 mm²
402-AL1/52-ST1A:	Composed Conductor type ACSR with Aluminium strands type AL1 (Hard-drawn Aluminium) conductor section 402.3 mm² rounded 402 mm² and Galvanized coating Steel strands class A, core section 52.2 mm² rounded 52 mm²
402-AL1/52-A20SA:	Composed Conductor type ACSR with Aluminium strands type AL1 (Hard-drawn Aluminium) conductor section 402.3 mm² rounded 402 mm² and Aluminium clad Steel strands (Aluminium grade A, class 20), core section 52.2 mm² rounded 52 mm²

Table A.1.2: Designation and stock code for i-DE ACSR Conductors (Galvanized Steel)

Designation	Old Designation	Sections			Strands Number		Strand Diameter		Outer Diameter		Linear Mass	Rated Break Load	Elasticity Modulus	Thermal Expansion Coefficient	D.C. Linear Resistance	Stock Code
		Aluminium	Steel	Total	Aluminium	Steel	Aluminium	Steel	Core	Conductor			E	α	@ 20ºC	
		mm²	mm²	mm²	nº	nº	mm	mm	mm	mm	kg/km	daN	daN/mm²	ºC·10^{-6}	Ω/km	
47-AL1/8-ST1A	LA 56	46.8	7.8	54.6	6	1	3.15	3.15	3.15	9.45	189.1	1640	7900	19.1	0.6136	5463004
67-AL1/11-ST1A	LA 78	67.4	11.2	78.6	6	1	3.78	3.78	3.78	11.34	272	2310	7900	19.1	0.4261	5463007
100-AL1/17-ST1A	LA 117	100	16.7	116.7	6	1	4.61	4.61	4.61	13.8	404	3433	7900	19.1	0.2869	5463116
107-AL1/18-ST1A	LA 125 PENGUIN	107	17.9	125.1	6	1	4.77	4.77	4.77	14.31	433	3680	7900	19.1	0.2675	5463012
152-AL1/25-ST1A	LA 175 OSTRICH	152	24.7	176.7	26	7	2.73	2.12	6.36	17.28	613	5500	7500	18.9	0.1900	5463017
147-AL1/34-ST1A	LA 180	147.3	34.3	181.6	30	7	2.50	2.50	7.50	17.50	676	6390	8000	17.8	0.1962	5463020
242-AL1/39-ST1A	LA 280 HAWK	241.7	39.4	281.1	26	7	3.44	2.68	8.04	21.8	977	8450	7500	18.9	0.1194	5463023
337-AL1/44-ST1A	LA 380 GULL	337.3	43.7	381.0	54	7	2.82	2.82	8.46	25.38	1275	10650	6900	19.3	0.0857	5463032
402-AL1/52-ST1A	LA 455 CONDOR	402.3	52.2	454.5	54	7	3.08	3.08	9.24	27.72	1521	12400	6900	19.3	0.0718	5463035
483-AL1/33-ST1A	LA 510 RAIL	483.4	33.4	516.8	45	7	3.70	2.47	7.39	29.59	1600	11580	6600	20.9	0.0599	5463038
485-AL1/63-ST1A	LA 545 CARDINAL	484.5	62.8	547.3	54	7	3.38	3.38	10.14	30.42	1832	14850	6900	19.3	0.0596	5463041
565-AL1/72-ST1A	LA 635 FINCH	565.0	71.6	636.6	54	19	3.65	2.19	10.95	32.85	2125	17500	6700	19.4	0.0511	5463047
806-AL1/56-ST1A	LA 860 LAWPING	805.7	55.6	861.3	45	7	4.77	3.18	9.54	38.16	2666	18700	6600	20.9	0.0359	5463056

NOTE: Shaded rows are the preferred conductors

Table A.1.3: Designation and stock code for i-DE ACSR/AW Conductors (Aluminium-clad Steel) **(*)**

Designation	Old Designation	Sections			Strands Number		Strand Diameter		Outer Diameter		Linear Mass	Rated Break Load	Elasticity Modulus	Thermal Expansion Coefficient	D.C. Linear Resistance	Stock Code
		Aluminium	Steel	Total	Aluminium	Steel	Aluminium	Steel	Core	Conductor			E	α	@ 20ºC	
		mm²	mm²	mm²	nº	nº	mm	mm	mm	mm	kg/km	daN	daN/mm²	ºC·10^{-6}	Ω/km	
47-AL1/8-A20SA	LARL 56	46.8	7.8	54.6	6	1	3.15	3.15	3.15	9.45	179.7	1720	7500	19.3	0.5808	5463604
67-AL1/11-A20SA	LARL 78	67.4	11.2	78.6	6	1	3.78	3.78	3.78	11.34	259	2300	7500	19.3	0.4033	5463607
100-AL1/17- A20SA	LARL 117	100.1	16.7	116.8	6	1	4.61	4.61	4.61	13.83	384	3270	7500	19.3	0.2716	5463711
107-AL1/18-A20SA	LARL 125 PENGUIN	107	17.9	125.1	6	1	4.77	4.77	4.77	14.31	412	3560	7500	19.3	0.2568	5463612
152-AL1/25-A20SA	LARL 175 OSTRICH	152	24.7	176.7	26	7	2.73	2.12	6.36	17.28	583	5550	7200	19.1	0.1824	5463616
147-AL1/34-A20SA	LARL 180	147.3	34.3	181.6	30	7	2.50	2.50	7.50	17.50	634	6630	7500	18.0	0.1818	5463619
242-AL1/39-A20SA	LARL 280 HAWK	241.7	39.4	281.1	26	7	3.44	2.68	8.04	21.8	929	8720	7200	19.1	0.1131	5463622
337-AL1/44-A20SA	LARL 380 GULL	337.3	43.7	381.0	54	7	2.82	2.82	8.46	25.38	1222	10870	6600	19.5	0.0820	5463628
402-AL1/52-A20SA	LARL 455 CONDOR	402.3	52.2	454.5	54	7	3.08	3.08	9.24	27.72	1457	12910	6600	19.5	0.0688	5463631
483-AL1/33-A20SA	LARL 510 RAIL	483.4	33.4	516.8	45	7	3.70	2.47	7.39	29.59	1560	11740	6300	21.1	0.0585	5463634
485-AL1/63-A20SA	LARL 545 CARDINAL	484.5	62.8	547.3	54	7	3.38	3.38	10.14	30.42	1755	15400	6600	19.5	0.0571	5463637
594-AL1/39-A20SA	LARL 600 BLUEJAY	593.9	39.1	603.0	45	7	4.00	2.66	8.00	31.98	1821	13700	6300	21.1	0.0502	5463640
565-AL1/72-A20SA	LARL 635 FINCH	565.0	71.6	636.6	54	19	3.65	2.19	10.95	32.85	2037	17630	6400	19.6	0.0490	5463643
725-AL1/92-A20SA	LARL 820 PLOVER	725.1	91.9	817.0	54	19	4.14	2.48	12.41	37.21	2628	22620	6400	19.6	0.0385	5463646

(*) Non-Standard Use

Table A.1.4: Designation and stock code for i-DE AAAC Conductors (*)

Designation	Old Designation	Section	Aluminium Strand Composition		Conductor Diameter	Linear Mass	Rated Break Load	Elasticity Modulus	Thermal Expansion Coefficient	D.C. Linear Resistance	Stock Code
			Number	Diameter				E	α	@ 20ºC	
		mm²	nº	mm	mm	kg/km	daN	daN/mm²	ºC·10^{-6}	Ω/km	
55-AL3	D56	54.6	7	3.15	9.45	149.3	1600	5900	23	0.6034	5466007
117-AL3	D110	117.0	19	2.80	14.00	322	3430	5600	23	0.2827	5466013
188-AL3	D180	188.1	19	3.55	17.8	516.3	5548	5600	23	0.1759	5466019
279-AL3	D280	279.3	37	3.10	21.7	769.3	8238	5500	23	0.1188	5466022
381-AL3	D400	381	61	2.82	25.38	1053	11180	5400	23	0.0872	5466025

(*) Non-Standard Use

ANNEX A2: SPEN

Meaning of the letters that make up the nomination:

Table A.2.1: Designation of Cable

Designation	Description
40/63/.../800	Conductor Section (Number), Section in mm² of Aluminium equivalent
AL*x* (Aluminium)	Conductor Material: *Aluminium*: *x* means Al type
7/11/.../101	Core Section (if composed), (Number), Section in mm² of Steel
ST*yz* (Galvanized coating)	Core Material (if composed): *Steel*: *y* means steel grade (1 to 6) *z* means galvanized coating class (A to E)

Example of designation:

53-AL1:	Aluminium strands type AL1 (Hard-drawn Aluminium) conductor section 52.83 mm² rounded 53 mm²
239 AL5 EHC:	Aluminium strands type AL5 (Aluminium Alloy type 5) EHC (Extra High Conductivity) conductor section 239.4 mm², round to 239 mm²
53-AL1/9-ST1A:	Composed Conductor type ACSR with Aluminium strands type AL1 (Hard-drawn Aluminium) conductor section 52.88 mm² rounded 53 mm² and Galvanized coating Steel strands class A, core section 8.81 mm² rounded 9 mm²

Table A.2.2: Designation and stock code for SPEN AAAC Conductors

Code	Old Designation	Section	Aluminium Strand Composition		Conductor Diameter	Linear Mass	Minimum Tensile Strength	Rated Break Load	Minimum Mass of Grease	Category of Grease	D.C Linear Resistance	Maximum Resistivity		Stock Code
			Number	Diameter							@ 20°C	Individual Wires	Mean of Lot	
		mm²	nº	mm	mm	kg/km	N/mm²	daN	kg/km	ENA ER L38	Ω/km	nΩ·m	nΩ·m	
60-AL3	50mm² Hazel	59.9	7	3.3	9.9	163.4	295	1766	1.54	Fully Greased Cat 4	0.5494	32.53	n/a	30980122
119-AL3	100mm² Oak	118.9	7	4.65	14	324.5	295	3507	3.06	Fully Greased Cat 4	0.2767	32.53	n/a	30980123
181-AL3	150mm² Ash	180.7	19	3.48	17.4	496.1	295	5331	11.13	Inner Layers Cat 3	0.1830	32.53	n/a	30980124
239-AL3	200mm² Poplar	239.4	37	2.87	20.1	659.4	295	7061	22.69	Inner Layers Cat 3	0.1387	32.53	n/a	30026579
239-AL5 EHC	200mm² Poplar	239.4	37	2.87	20.1	659.4	295	7061	22.69	Inner Layers Cat 3	0.1300	31.5	30.5	30037942
303-AL3	250mm² Sycamore	303.2	37	3.23	22.6	834.0	295	8940	28.25	Inner Layers Cat 3	0.1090	32.53	n/a	30060917
303-AL5 EHC	250mm² Sycamore	303.2	37	3.23	22.6	834.0	295	8944	28.25	Inner Layers Cat 3	0.1020	31.5	30.5	30060652
362-AL3	300mm² Upas	362.1	37	3.53	24.7	997.5	295	10682	34.35	Inner Layers Cat 3	0.0917	32.53	n/a	30980125
362-AL5 EHC	300mm² Upas	362.1	37	3.53	24.7	997.5	295	10682	34.35	Inner Layers Cat 3	0.0859	31.5	30.5	30037943
498-AL5 EHC	425mm² Totara	498.1	37	4.14	29	1372.1	295	14693	47.25	Inner Layers Cat 3	0.0626	31.5	30.5	30037944
587-AL5 EHC	500mm² Rubus	586.9	61	3.5	31.5	1622.0	295	17313	67.54	Inner Layers Cat 3	0.0530	31.5	30.5	30037945
821-AL5 EHC	700mm² Araucaria	821.1	61	4.14	37.3	2269.4	295	24224	94.49	Inner Layers Cat 3	0.0380	31.5	30.5	30061978

Table A.2.3: Designation and stock code for SPEN ACSR & CACSR Conductors

Designation	Old Designation	Sections			Strands Number		Strand Diameter		Outer Diameter		Linear Mass	Rated Break Load	Min Mass of Grease	D.C. Linear Resistance	Stock Code
		Aluminium	Steel	Total	Aluminium	Steel	Aluminium	Steel	Core	Conductor				@ 20ºC	
		mm²	mm²	mm²	nº	nº	mm	mm	mm	mm	kg/km	daN		Ω/km	
26-AL1/4-ST1A	25mm² Gopher	26.25	4.37	30.62	6	1	2.36	2.36	2.36	7.08	106.0	960	0.79	1.093	30980132
26-AL1/9-ST1A CACSR	25mm² Caton	26.2	8.81	38.93	6	1	2.36	3.35	3.35	7.04	136.0	1,440	0.79	1.096	30980121
53-AL1/9-ST1A	50mm² Rabbit	52.88	8.81	61.69	6	1	3.35	3.35	3.35	10.05	213.5	1,836	1.59	0.543	30980133
73-AL1/43-ST1A	70mm² Horse	73.36	42.8	116.2	12	7	2.79	2.79	8.37	13.95	537.3	6,119	7.15	0.394	30982972
105-AL1/14-ST1A	100mm² Dog	105.0	13.55	118.6	6	7	4.72	1.57	4.71	14.15	394.0	3,268	2.26	0.273	30980134
159-AL1/9-ST1A	150mm² Dingo	158.7	8.81	167.5	18	1	3.35	3.35	3.35	16.75	505.2	3,572	10.31	0.181	30980136
158-AL1/37-ST1A	150mm² Wolf	158.1	36.88	195.0	30	7	2.59	2.59	7.77	18.13	725.3	6,924	18.49	0.183	30980135
183-AL1/43-ST1A	175mm² Lynx	183.4	42.8	226.2	30	7	2.79	2.79	8.37	19.53	841.6	79.79	21.46	0.158	30037946

Table A.2.4: Designation and stock code for SPEN Copper Conductors

Section	Class	Copper Strand Composition		Conductor Diameter	Linear Mass	Rated Break Load	D.C. Linear Resistance @ 20ºC	PVC Covering	PVC Type	Stock Code
		Number	Diameter							
mm²		nº	mm	mm	kg/km	daN	Ω/km	mm		
16mm²	-	3	2.65	5.70	148.3	6,194	1.082	bare	-	30980114
16mm²	2	3	2.65	5.70	148.3	6,194	1.082	0.8	Type 8 Black	30980128
16mm²	2	3	2.65	5.70	148.3	6,194	1.082	1.6	Type 16 Green	30980130
32mm²	-	3	3.75	8.06	296.9	1,240	0.540	bare	-	30980115
70mm²	-	7	3.55	10.65	621.1	2,593	0.259	bare	-	30980117

Table A.2.5: Designation and stock code for SPEN Flexible Conductor										
Section	Conductor Material	Class	Conductor Strand Composition		Conductor Diameter	Linear Mass	D.C. Linear Resistance @ 20ºC	PVC Covering	PVC Type	Stock Code
			Number	Diameter						
mm²			nº	mm	mm	kg/km	Ω/km	mm	-	
35	Copper	5	1,120	0.21	9.8	343	0.554	1.2	TI1 Black	30980875
70	Copper	5	990	0.31	13.5	668	0.272	1.4	TI1 Black	30026399
50	Aluminium	5	358	0.46				0.9	TI1 Black	30980871

ANNEX A3: AVANGRID

Table A.3.1: Designation and Stock Code for AVANGRID AAC, AAAC, ACAR & ACSS Conductors

Code word	Conductor type	Stranding	Conductor Area	Conductor Area			Overall Rated Strength	Overall Nominal Diameter	Conductor weight			RESISTANCE*				Minimum Conductor Reel Length	Nominal Conductor Reel Length	Reel design maximum size	Stock Code (MID's)
				Aluminum	Steel	Total			Aluminum	Steel core	Total	DC@ 20ºC	AC@ 25ºC	AC@ 50ºC	AC@ 75ºC				
			kcmil	in²	in²	in²	lb	in	lb/ 1000ft	lb/ 1000ft	lb/ 1000ft	ohm/ mi	ohm/ mi	ohm/ mi	ohm/ mi	ft	ft		
Tulip	AAC	19	336.4	0.2644	N/A	0.2644	6,150	0.666	315.5	N/A	315.5	0.2713	0.2779	0.3052	0.3325	N/A	6,015	NR48.28	30924173
Cosmos	AAC	19	477	0.3744	N/A	0.3744	8,360	0.793	446.8	N/A	446.8	0.1913	0.1968	0.2159	0.2352	N/A	4,245	NR48.28	30924252
Arbutus	AAC	37	795	0.6245	N/A	0.6245	13,900	1.026	745.3	N/A	745.3	0.1148	0.1197	0.1311	0.1425	N/A	4,960	NR 66.28	30924189
Bluebell	AAC	37	1033.5	0.8114	N/A	0.8114	17,700	1.170	968.3	N/A	968.3	0.0883	0.0934	0.1020	0.1107	N/A	7,630	RMT84.45	30924283
Hawthorn	AAC	61	1192.5	0.9363	N/A	0.9363	21,100	1.258	1117	N/A	1117	0.0765	0.0819	0.0893	0.0967	N/A	9,340	RMT90.45	30924284
Narcissus	AAC	61	1272	0.9990	N/A	0.9990	22,000	1.300	1192	N/A	1192	0.0717	0.0772	0.0841	0.0912	N/A	8,170	RMT90.45	30924169
Carnation	AAC	61	1431	1.1244	N/A	1.1244	24,300	1.379	1342	N/A	1342	0.0638	0.0695	0.0756	0.0817	N/A	7,270	RMT90.45	30924285
Coreopsis	AAC	61	1590	1.2480	N/A	1.2480	27,000	1.454	1498	N/A	1498	0.0574	0.0635	0.0689	0.0743	N/A	6,540	RMT90.45	30924170
Azusa	AAAC	7	1/0	0.0968	N/A	0.0968	4,270	0.398	114.9	N/A	114.9	0.8628	0.8782	0.9530	1.0278	N/A	6,000	NR 36.22	30924225
N/A	ACAR	42/19	1277	--	N/A	--	28,400	1.302	1198.0	N/A	1198.0	--	--	--	--	N/A	12,000	RMT96.60	30924255
Lapwing	ACSS	45/7	1590	1.2492	0.0863	1.3355	27,900	1.504	1498.1	292.2	1790.3	0.0555	0.0605	0.0662	0.0718	N/A	6,000	RMT90.45	30053688

*All AC resistances at 60Hz.

Table A.3.2: Designation and Stock Code for AVANGRID ACSR Conductors

Code word	Conductor type	Stranding	Conductor Area	Conductor Area			Overall Rated Strength	Overall Nominal Diameter	Conductor weight			RESISTANCE*				Minimum Conductor Reel Length	Nominal Conductor Reel Length	Reel design maximum size	Stock Code (MID's)
				Aluminum	Steel	Total			Aluminum	Steel core	Total	DC@ 20ºC	AC@ 25ºC	AC@ 50ºC	AC@ 75ºC				
			kcmil	in²	in²	in²	lb	in	lb/ 1000ft	lb/ 1000ft	lb/ 1000ft	ohm/ mi	ohm/ mi	ohm/ mi	ohm/ mi	ft	ft		
Swanate	ACSR	7/1	#4 AWG	0.0328	0.0083	0.0411	2,360	0.257	38.9	28.0	66.9	2.1049	2.1473	2.5201	2.7705	N/A	17,910	NR38.22	30924288
Sparate	ACSR	7/1	#2 AWG	0.0522	0.0133	0.0655	3,640	0.325	61.9	44.7	106.6	1.3239	1.3506	1.6190	1.7845	N/A	11,250	NR38.22	30924282
Petrel	ACSR	12/7	101.8	0.0799	0.0466	0.1265	10,400	0.461	95.9	157.9	253.8	0.8358	0.8526	1.1698	1.3168	N/A	N/A	--	30924257
Raven	ACSR	6/1	1/0	0.0830	0.0138	0.0968	4,380	0.398	98.5	46.6	145.1	0.8414	0.8585	1.0412	1.1400	N/A	12,190	NR42.28	30924256
Quail	ACSR	6/1	2/0	0.1045	0.0174	0.1219	5,310	0.447	124.1	58.7	182.8	0.6676	0.6813	0.8402	0.9203	N/A	9,670	NR42.28	30924267
Pigeon	ACSR	6/1	3/0	0.1317	0.0220	0.1537	6,620	0.502	156.4	74.0	230.4	0.5295	0.5405	0.6795	0.7433	N/A	7,670	NR42.28	30924392
Penguin	ACSR	6/1	4/0	0.1662	0.0277	0.1939	8,350	0.563	197.4	93.4	290.8	0.4199	0.4288	0.5510	0.5999	N/A	6,080	NR42.28	30924274
Owl	ACSR	6/7	266.8	0.2096	0.0272	0.2368	9,645	0.633	251.4	92.0	343.4	0.3379	0.3452	0.4679	0.4834	N/A	N/A	--	30924271
Waxwing	ACSR	18/1	266.8	0.2094	0.0116	0.2210	6,880	0.609	249.9	39.2	289.1	0.3396	0.3471	0.3813	0.4155	N/A	14,360	RM66.32	30924270
Merlin	ACSR	18/1	336.4	0.2642	0.0147	0.2789	8,680	0.684	315.3	49.5	364.8	0.2693	0.2756	0.3027	0.3298	N/A	11,390	RM66.32	30924272
Linnet	ACSR	26/7	336.4	0.2640	0.0428	0.3070	14,100	0.720	316.6	145.4	462.0	0.2668	0.2728	0.2996	0.3264	N/A	16,390	RMT84.36	30924175
Oriole	ACSR	30/7	336.4	0.2642	0.0617	0.3259	17,300	0.741	317.7	208.7	526.4	0.2650	0.2708	0.2974	0.3240	N/A	9,430	RM66.32	30924273
Pelican	ACSR	18/1	477	0.3747	0.0208	0.3955	11,800	0.814	447.1	70.2	517.3	0.1899	0.1950	0.2141	0.2331	N/A	8,030	RM66.32	30924186

*All AC resistances at 60Hz.

Table A.3.2: Designation and Stock Code for AVANGRID ACSR Conductors

Code word	Conductor type	Stranding	Conductor Area	Conductor Area			Overall Rated Strength	Overall Nominal Diameter	Conductor weight			RESISTANCE*				Minimum Conductor Reel Length	Nominal Conductor Reel Length	Reel design maximum size	Stock Code (MID's)
				Alumi num	Steel	Total			Aluminum	Steel core	Total	DC@ 20ºC	AC@ 25ºC	AC@ 50ºC	AC@ 75ºC				
			kcmil	in²	in²	in²	lb	in	lb/ 1000ft	lb/ 1000ft	lb/ 1000ft	ohm/ mi	ohm/ mi	ohm/ mi	ohm/ mi	ft	ft		
Hawk	ACSR	26/7	477	0.3744	0.0610	0.4354	19,500	0.858	449.0	206.4	655.3	0.1882	0.1928	0.2117	0.2305	N/A	11,560	RMT84.36	30924275
Hen	ACSR	30/7	477	0.3747	0.0874	0.4621	23,800	0.883	450.4	296.0	746.4	0.1869	0.1913	0.2100	0.2288	N/A	6,650	RM66.32	30924188
Drake	ACSR	26/7	795	0.6247	0.1017	0.7264	31,500	1.108	749.1	344.3	1093.4	0.1129	0.1166	0.1278	0.1390	N/A	3,470	NR 60.28	30924277
Mallard	ACSR	30/19	795	0.6245	0.1424	0.7669	38,400	1.140	750.7	483.2	1233.9	0.1122	0.1156	0.1268	0.1380	N/A	7,980	RMT84.45	30924278
Coot	ACSR	36/1	795	0.6244	0.0173	0.6417	16,800	1.040	745.1	58.5	803.6	0.1144	0.1190	0.1303	0.1417	N/A	9,640	RMT84.45	30924333
Tern	ACSR	45/7	795	0.6242	0.0432	0.6674	22,100	1.063	748.6	146.1	894.7	0.1143	0.1185	0.1305	0.1422	N/A	12,000	RMT90.45	30924279
Canary	ACSR	54/7	900	0.7069	0.0916	0.7985	31,900	1.162	847.7	310.2	1157.9	0.1002	0.1039	0.1165	0.1273	N/A	10,180	RMT90.45	30924281
Ortolan (non-specular)	ACSR	45/7	1033.5	0.8112	0.0561	0.8673	27,700	1.212	972.8	189.9	1162.7	0.0879	0.0921	0.1013	0.1102	N/A	9,230	RMT90.45	30924258
Curlew	ACSR	54/7	1033.5	0.8112	0.1052	.9164	36,600	1.245	972.8	356.0	1328.8	0.0872	0.0910	0.1018	0.1112	N/A	8,870	RMT90.45	30924261
Bluejay	ACSR	45/7	1113	0.8745	0.0605	0.9350	29,800	1.259	1048.7	204.8	1253.6	0.0816	0.0859	0.0943	0.1026	N/A	8,570	RMT90.45	30924262
Bunting	ACSR	45/7	1192.5	0.9367	0.0647	1.0014	32,000	1.302	1123.4	219.1	1342.5	0.0762	0.0805	0.0884	0.0960	N/A	8,000	RMT90.45	30924263
Bobolink	ACSR	45/7	1431	1.1236	0.0777	1.2013	38,300	1.427	1347.5	263.1	1610.6	0.0635	0.0681	0.0745	0.0808	N/A	6,665	RMT90.45	30924265
Falcon	ACSR	54/19	1590	1.2489	0.1583	1.4072	54,500	1.545	1505.0	537.0	2042.1	0.0570	0.0611	0.0679	0.0739	N/A	5,740	RMT90.45	30924266
Bluebird	ACSR	84/19	2156	1.6931	0.1378	1.8309	60,300	1.762	2040.4	467.5	2507.9	0.0423	0.0477	0.0516	0.0555	N/A	7,500	RMT96.60	30924268

*All AC resistances at 60Hz.

Table A.3.3: Designation and Stock Code for AVANGRID Copper Conductors

Conductor type	Stranding	Temper	Conductor Area	Conductor Area	Overall Rated Strength	Nominal Diameter		Conductor weight	RESISTANCE*				Minimum Conductor Reel Length	Nominal Conductor Reel Length	Reel design maximum size	Stock Code (MID's)
				Total		Individual Wire	Total	Total	DC@ 20ºC	AC@ 25ºC	AC@ 50ºC	AC@ 75ºC				
			kcmil	in²	lb	in	in	lb/ 1000ft	ohm/ mi	ohm/ mi	ohm/ mi	ohm/ mi	ft	ft		
Copper	Solid	Soft	#6 AWG	0.0206	763	0.1620	0.1620	79.4	2.1702	2.2114	2.4170	2.6226	N/A	N/A	--	30924155
Copper	Solid	Soft†	#6 AWG	0.0206	--	0.1620	0.1620	79.4	2.1702	2.2114	2.4170	2.6226	N/A	2,500	--	30924317
Copper	7	Soft	#4 AWG	0.0328	1320	0.0772	0.2316	128.9	1.3916	1.4181	1.5500	1.6818	N/A	N/A	--	30991315
Copper	Solid	Medium Hard	#4 AWG	0.0328	1584	0.2043	0.2043	126.3	1.3643	1.3903	1.5196	1.6488	N/A	N/A	--	30924154
Copper	7	Medium Hard	#4 AWG	0.0328	1505	0.0772	0.2316	128.9	1.3916	1.4181	1.5500	1.6818	N/A	N/A	--	30924153
Copper	Solid	Medium Hard	#2 AWG	0.0521	2450	0.2576	0.2576	200.9	0.8581	0.8747	0.9560	1.0373	N/A	N/A	--	30924316
Copper	7	Soft	#2 AWG	0.0522	2110	0.0974	0.2922	204.9	0.8752	0.8921	0.9750	1.0579	N/A	1,000	--	30924166
Copper	7	Medium Hard	#2 AWG	0.0522	2360	0.0974	0.2922	204.9	0.8752	0.8921	0.9750	1.0579	N/A	N/A	--	30924152
Copper	7	Soft	1/0 AWG	0.0829	3221	0.1228	0.3684	325.9	0.5506	0.5615	0.6137	0.6658	N/A	N/A	--	30924156
Copper	7	Medium Hard	1/0 AWG	0.0829	3705	0.1228	0.3684	325.9	0.5506	0.5615	0.6137	0.6658	N/A	6,250	--	30924319
Copper	19	Soft	1/0 AWG	0.0828	--	0.0745	0.3725	325.6	0.5506	0.5615	0.6137	0.6658	N/A	N/A	--	30991316
Copper	7	Soft	2/0 AWG	0.1045	4062	0.1379	0.4137	411.0	0.4364	0.4364	0.4866	0.5279	N/A	4,950	--	30924172
Copper	Solid	Medium Hard	4/0 AWG	0.1662	6980	0.4600	0.4600	640.5	0.2668	0.2730	0.2983	0.3237	N/A	N/A	--	30924183
Copper	7	Soft	4/0 AWG	0.1663	6459	0.1739	0.5217	653.6	0.2745	0.2808	0.3067	0.3326	N/A	1,000	--	30924326

* All AC resistances at 60Hz.
† Utility grade dead soft annealed with 40% to 42% elongation.

Table A.3.3: Designation and Stock Code for AVANGRID Copper Conductors

Conductor type	Stranding	Temper	Conductor Area	Conductor Area	Overall Rated Strength	Nominal Diameter		Conductor weight	RESISTANCE*				Minimum Conductor Reel Length	Nominal Conductor Reel Length	Reel design maximum size	Stock Code (MID's)
				Total		Individual Wire	Total	Total	DC@ 20ºC	AC@ 25ºC	AC@ 50ºC	AC@ 75ºC				
			kcmil	in²	lb	in	in	lb/ 1000ft	ohm/ mi	ohm/ mi	ohm/ mi	ohm/ mi	ft	ft		
Copper	7	Medium Hard	4/0 AWG	0.1663	7278	0.1739	0.5217	653.6	0.2745	0.2808	0.3067	0.3326	N/A	3,100	--	30924182
Copper	19	Soft	4/0 AWG	0.1661	6453	0.1055	0.5275	652.9	0.2745	0.2808	0.3067	0.3326	N/A	N/A	--	30924180
Copper	19	Soft	350 KCMIL	0.2748	10680	0.1357	0.6785	1080.3	0.1660	0.1709	0.1865	0.2021	N/A	5,950	--	30924157
Copper	37	Soft	500 KCMIL	0.3924	15240	0.1162	0.8134	1542.5	0.1162	0.1209	0.1317	0.1425	N/A	650	--	30924158

*All AC resistances at 60Hz.

ANNEX A4: NEOENERGIA

Table A.4.1: Designation and stock code for NEOENERGIA ACSR Conductors (Galvanized Steel)

Conductor Name	Gauge (AWG or MCM)	Section (mm²)			Stranding & wire diameter				Diameter (mm)	Linear mass (kg/km)			Rated strength (kN)		DC Resistance (Ω/Km)	Stock Code		
					Aluminium		Steel											
		Aluminium	Steel	Total	Wire	Diameter (mm)	Wire	Diameter (mm)		Aluminium	Steel	Conductor	Class A	Class B	20°C	Northeast	Southeast	Brasília
SWAN	4	21.18	3.53	24.71	6	2.12	1	2.12	6.36	58.1	27.5	85.6	8.30	8.07	1.3545	2202040	30440	31010008
SPARROW	2	33.59	5.6	39.19	6	2.67	1	2.67	8.01	92.2	43.6	135.8	12.65	12.28	0.8541	-	30441	31010007
RAVEN	1/0	53.52	8.92	62.44	6	3.37	1	3.37	10.11	146.8	69.4	216.2	19.46	18.86	0.5360	2202041	30432	31010009
QUAIL	2/0	67.33	11.22	78.55	6	3.78	1	3.78	11.34	185.47	86.57	272.04	23.53	22.77	0.4246	-	30442	-
PENGUIM	4/0	107.22	17.87	125.09	6	4.77	1	4.77	14.31	294.2	139	433.2	37.06	35.85	0.2676	2202043	30443	31010013
LEGHORN	134,6	68.2	39.78	107.98	12	2.69	7	2.69	13.45	189	310.7	499.7	60.6	57.93	0.4248	2202058	52557	31010019
LINNET	336,4	170.55	27.83	198.38	26	2.89	7	2.25	18.31	472.5	217.4	689.9	62.91	61.04	0.1699	2202044	32624	31010036
ORIOLE	336,4	170.5	39.78	210.28	30	2.69	7	2.69	18.83	473.5	310.7	784.2	77.26	74.59	0.1703	-	33293	31010025
HAWK	477	241,65	39,49	281,13	26	3,44	7	2,68	21,80	670,07	307,87	977,94	87,18	84,52	0,1195	2202046	30790	31010041
GROSBEAK	636	321.84	52.49	374.33	26	3.97	7	3.09	25.15	891.7	410	1301.7	111.9	108.3	0.0900	2202047	31280	31010026
DRAKE	795	402.56	65.44	468	26	4.44	7	3.45	28.11	1115.3	511.2	1626.5	139.7	135.3	0.0720	2202059	36656	31010037
TERN	795	403.77	27.83	431.60	45	3.38	7	2.25	27.03	1118.74	217.34	1336.08	98.20	96.33	0.0715	-	-	31010039

Table A.4.2: Designation and stock code for NEOENERGIA Aluminum Wire, AAC & AAAC Conductors

Conductor Name	Gauge (AWG orMCM)	Conductor type	Cross Section	Aluminium Strand Composition		Conductor Diameter	Linear Mass	Rated Strength	D.C. Linear Resistance	Stock Code		
				Number	Diameter				@ 20ºC			
			mm²	nº	mm	mm	kg/km	KN	Ω/km	Northeast	Southeast	Brasília
-	4	H14 H24 Aluminum Wire	21.15	1	5.19	5.19	57.2	2.18	1.3373	2200002	50418	31010038
IRIS	2	AAC	33.54	7	2.47	7.41	92.48	5.99	0.8567	2202048	30451	31010029
ASTER	2/0	AAC	67.35	7	3.50	10.50	185.68	11.12	0.4266	-	30463	31010028
CANNA	397.5	AAC	202,09	19	3.68	18.40	557.2	31.76	0.1422	2202080	31281	31010034
ORCHID	636.0	AAC	322.24	37	3.33	23.31	888.84	50.44	0.0892	2202054	30994	31010024
ARBUTUS	795.0	AAC	402,14	37	3.72	26.04	1,109	61.85	0.0715	2202079	37449	31010035
AMES	77.47	AAAC	39.19	7	2.67	8.01	107.54	12.45	0.8547	2202070	36961	31010033
ANAHEIM	155.4	AAAC	78.55	7	3.78	11.34	215.54	23.91	0.4264	2202069	36962	31010032
ALLIANCE	246.9	AAAC	125.09	7	4.77	14.31	343.22	38.07	0.2678	2202014	35621	31010030
CANTON	394.5	AAAC	199,90	19	3,66	18,30	548,48	58,93	0,1676	2202086	38345	-
CAIRO	465.4	AAAC	236.38	19	3.98	19.90	648.58	69.69	0.1417	2202015	35622	31010031
DARIEN	559.5	AAAC	283,67	19	4,36	21,80	778,34	83,63	0,1181	2202087	38346	-
FLINT	740.8	AAAC	374,52	37	3,59	25.13	1027.62	108.04	0.0894	2202033	38144	31010040

Table A.4.3: Designation and stock code for NEOENERGIA Bare Copper Conductors											
Section	Temper	Stranding Class (NBR 6524)	Copper Strand Composition		Conductor Diameter	Linear Mass	Rated Strength		D.C. Linear Resistance	Stock Code		
			Number	Diameter			MIn	Máx	@ 20ºC			
mm²			nº	mm	mm	kg/km	KN		Ω/km	Northeast	Southeast	Brasília
10mm²	Soft	1A	1	3.5	3.5	85.5	NBR 5111		1.8	2201014	50422	31065004
16MM²	Medium-Hard	1A	1	4.5	4.5	141	NBR 5111		1.14	2201013	34418	31065002
25mm²	Medium-Hard	2A	7	2.06	6.18	207.4	7.39	9.82	0.795	2203009	30459	31020006
35mm²	Medium-Hard	2A	7	2.50	7.50	305.5	10.73	14.29	0.538	2203008	30465	31020001
70mm²	Medium-Hard	3A	19	2.12	10.60	602	21.06	28.02	0.276	2203021	30466	31020003
95mm²	Medium-Hard	3A	19	2.50	12.50	837	29.12	38.79	0.198	2203036	32410	31020008
120mm²	Medium-Hard	3A	37	2.06	14.42	1,107	38.97	51.83	0.150	2203037	30462	31020004

Table A.4.4: Designation and stock code for NEOENERGIA Copper Clad Steel Conductors

Nominal Cross Section	Effective Cross Section	Gauge	Steel Strand Composition		Conductor Diameter	Linear Mass	Rated Strength	D.C. Linear Resistance	IACS Conductivity	Current Capacity	Stock Code		
			Number	Diameter				@ 20ºC		75 ºC			
			nº	mm	mm	kg/km	KN	Ω/km	%	A	Northeast	Southeast	Brasília
mm²	mm²	AWG											
-	21.16	4	1	5.19	5.19	173	5.95	2.04	40	125	2205000	35623	23015018
35	31.9	2	3	3.67	7.91	261	8.4	1.349	40	168	2206000	35624	23015016
70	74.7	2/0	7	3.67	11.01	612	18.7	0.576	40	280	2206004	32626	23015014
95	93.7	3/0	7	4.11	12.33	767	23.6	0.459	40	323	2206012	32453	23015015
120	127.6	4/0	19	2.91	14.55	1045	31.9	0.337	40	395	2206008	35835	23015017

ANNEX D: ADDITIONAL CHARACTERISTICS AND TESTS

ANNEX D1: i-DE

D1.1 Design and Manufacture of Conductor

D1.1.1 General

The main features of cabled conductor shall be as described in standard EN 50182.

Before the batch manufacture, the manufacturer shall provide a sample for the receipt and verification of parameters to be used on manufacturing.

Conductor tightened: The conductor tightened shall be sufficient to allow an easy installation. This will be tested on the entire conductor test.

Strand tension: The manufacturer shall inform to Iberdrola about the strand tension during manufacture. It cannot vary without consent of Iberdrola.

D1.1.2 Grease

No grease is considered for i-DE conductors.

D1.2 Tests as EN 50182

Type and sample tests described on table 5, chapter 6 of EN50182 applies.

Additionally the stress – strain curves test and breaking strength test shall be done as described on table 5, chapter 6 and annex C of EN50182.

For qualification, the stringing test indicated in table 5, chapter 6 and annex E of EN50182 shall be done.

D1.3 Transport, Packing, Storage and Installation

Conductor shall be transported in wood drums as described at UNE 21045. Interior protection and external painting can be omitted by the manufacturer.

If requested by the purchaser, conductor can be packed on metallic drum according to UNE 21162

Tolerances of longitude on drum should be from -0% to +2%.

The drum is usually closed with wooden staves.

By agreement between Iberdrola and manufacturer, may be allowed other closure systems, for example laminated of wood fibres with plastic protection externally, resulting damp-proof packaging. This type of packaging will be on drums with a cover diameter not exceeding 1,320 mm. The drums closed with this system shall be stacked with instructions of the manufacturer.

Table D.1: Length marking for i-DE Conductors				
Stock Code	Conductor Designation	Drum type	Conductor length marking (m)	Approximate maximum weight (kg)
5463004	47-AL1/8-ST1A	114/66	3000	565
5463007	67-AL1/11-ST1A	114/66	2100	565
5463012	107-AL1/18-ST1A	138/76	2000	860
5463017	152-AL1/25-ST1A	188/86	4000	2450
5463020	147-AL1/34-ST1A	188/86	3500	2360
5463023	242-AL1/39-ST1A	188/86	2500	2450
5463032	337-AL1/44-ST1A	186/117	2775	3540
5463116	100-AL1/17-ST1A	138/76	2225	900
5463035	402-AL1/52-ST1A	186/117	2225	3375
5463038	483-AL1/33-ST1A	186/117	2225	3550
5463041	485-AL1/63-ST1A	186/117	1900	3475

The manufacturer shall provide a document indicating how to handle, transport and store drums for each batch.

The drums shall be labelled with a QR code, printed on plastic format, attached to the drum or in a plastic envelope attached to the drum by any means that prevents its deterioration in the transportation and storage process.

The required dimension and information format will be specified in document MT 2.02.01, and will include at least the following information:

- Manufacturer's brand or initials.
- Serial number or manufacturing batch.
- Conductor model.
- Manufacturing date.
- Conductor section.
- Conductor designation in accordance with this document.
- Material code

D1.4 Qualification and Acceptance

D1.4.1 Qualification

In general, the procedure for suppliers and products qualification shall accomplish to NI 00.08.00 “Calificación de suministradores y productos tipificados”.

Iberdrola reserves the right of repeat some tests done by the manufacturer or at the stage of obtaining the quality mark.

The qualification procedure includes the tests as indicated on D2.

Once done the qualification procedure, the manufacturer shall develop for each product an annex of quality management to be performed by Iberdrola.

D1.1.1 Acceptance

The acceptance criteria can be varied by Iberdrola, it depends on the manufacturer quality system and the relation between Iberdrola and supplier of the product (experience, agreed quality, etc.).

The criteria are defined on standard UNE 21044.

The first batch manufactured and presented for acceptance does not exceed the 40 % of the purchase order.

The drum sample quantity for the entire cable test, diameter variation, breaking load tests shall be of:

$$2 + \frac{2b}{25}$$

With b the drums number of entire batch.

On each drum both tests shall be done. Two more tests should be successful for validation if one test doesn’t pass.

Two drums rejection may cause rejection of entire batch.

ANNEX D2: SPEN

D2.1 Design and Manufacture of Conductor

D2.1.1 General

Conductors shall comply with the requirements of EN 50182, , EN 50189, EN 60889 and IEC 62641 as appropriate except where modified in this specification.

Conductors shall be post-formed so that they remain inert and do not move relative to each other when the conductor is cut. The method of post-forming used shall not cause damage to the wires, the galvanizing of steel wires or the aluminium cladding of the steel wires. Smooth compression ellipses of up to 3mm in length in the aluminium or aluminium alloy shall be acceptable. The surface of the conductor shall be free of nicks, cuts imperfections which could generate audible noise due to corona generation at service voltages.

The method of jointing single aluminium wires shall be by cold pressure welding. There shall be no joints in the steel wires.

When the conductor is cut, it shall be inert with no tendency to twist or the ends to splay.

D2.1.2 Grease

Overhead line conductor greasing shall comply with the requirements of Energy Networks Association Engineering Recommendation L38. Flexible sheathed conductors and the phase and neutral cores of LV aerial bundled conductors shall not be greased

Copper Conductors: Bare and PVC covered copper conductors shall not be greased.

Aluminium Conductors: **Fully Greased and Wiped** – All inner wires shall be covered with grease and the inner interstices of the outer layer shall be filled with grease. The outer surface of the conductor shall be wiped clean of grease.

Internally Fully - All inner wires shall be covered with grease such that the interstices are filled to the diameter of the penultimate layer. No grease shall be visible on the outer surface of the conductor.

Centre Wire - the centre wire of Type 8 and Type 16 PVC covered aluminium conductors shall be covered in a continuous film of grease that need not fill the interstices. No grease shall be visible on the outer surface of the conductor and the level of greasing shall not inhibit the adhesion of the PVC covering to the conductor.

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AL5 EHC conductors AL5 EHC conductors shall be allied with grease that is suitable where operating temperatures are between -20°C and +150°C.

Other Conductors: Other conductors that require grease shall be allied with grease that is suitable where the operating temperatures are between -20°C and +125°C.

D2.1.3 Resistivity of Aluminium Conductors

- The maximum resistivity of the aluminium alloy wires of AAAC, AACSR and ACAR (averaged, in each case, over all the alloy wires) shall be 30.5nΩm at 20ºC. This is designated Extra High Conductivity (EHC) conductor. However at Distribution voltages, Energy Networks may specify High Conductivity (HC) for specific projects. The maximum resistivity of HC conductor shall be 31.2nΩm at 20ºC.
- Where conductors are designated AL3, the maximum resistivity of the aluminium alloy wires (averaged, in each case, over all the alloy wires) shall be 32.53nΩm at 20ºC.
- Where conductors are designated AL1, the maximum resistivity of the aluminium wires (averaged, in each case, over all the wires) shall be 28.26nΩm at 20ºC.

D2.1.4 Tensile Strength

The minimum tensile stress at break for the aluminium alloy shall be 295 MPa.

D2.1.5 Cross Contamination

Precautions shall be taken during the manufacture, storage and delivery of conductors to prevent contamination by any other materials, which may adversely affect the aluminium strands by embrittlement or corrosion, in particular, copper. In the event of any machinery used for conductor manufacture being used for materials other than aluminium, aluminium alloy or galvanized steel strands, the manufacturer shall furnish the Energy Networks-appointed inspector with a certificate stating that the machinery has been thoroughly cleaned before use and that the conductor is free from contamination.

D2.1.6 Conductor Length

Suppliers will be required to supply conductor in both standard lengths and in job specific section lengths. The Price Schedule provides details on the normal standard length requirements for each conductor type. Additionally it indicates those conductor types that typically require a section length or ordered as required length (OAR).

Standard lengths of conductor to be supplied on drums are stated in the price schedules. Where there is a requirement for different lengths to suit specific installations, this will be stated at the time of ordering. The manufacturer shall ensure that the measured length on the drums is accurate to the ordered length to within the following tolerance: +1% -0%.

D2.1.7 CACSR

The 25mm² compacted ACSR conductor (26-AL1+9-ST1A) shall comprise of a single hot dipped galvanised steel wire core around which are stranded six aluminium wires. During stranding, the individual wires shall be ovalised by rollers immediately before entering a circular closing die, which compresses the wires into a segmental form, thus finishing the conductor with a circular surface.

D2.1.9 PVC covered HDC conductors

PVC covered hard drawn copper conductors shall be manufactured and supplied in accordance with BS 7884. The conductors shall be PVC covered in accordance with BS 6485 Type 16 colour green or BS 6485 Type 8 colour black.

D2.2 PVC Covered Flexible Conductors

The conductors shall be single core flexible conductor manufactured generally in accordance with BS 6231 type BK.

The core of the copper conductors shall be Class 5 plain annealed copper in accordance with IEC 60228 and shall be insulated with black PVC type TI 1 in accordance with BS 6231.

The core of the aluminium conductor shall be Class 5 plain annealed aluminium in accordance with IEC 60228 and shall be insulated with black PVC type TI 1 in accordance with BS 6231.

D2.3 Tests

D2.3.1 Type Tests

Type tests are intended to verify the main characteristics of the conductor, which depend mainly on its design and manufacturing process. They shall be repeated when the design or manufacturing process is significantly changed.

The technical parameters of the conductors and materials of manufacture shall be provided as specified below based on the sample tests defined below. If the procurement contract document specifies the requirement for a stress-strain test, this shall be performed according to EN 50182.

The conductor manufacturer shall supply the following information based on measurements made according to the specified standards

Conductor	
Nominal cross-sectional area	
Actual cross-sectional area of aluminium alloy/aluminium/copper	mm²
Actual cross-sectional area of steel	mm²
Number of wires in each layer	
Diameter and tolerance of wire	mm
Lay ratio	
Overall diameter	mm
Rated tensile strength of conductor	N
Mass per unit, ungreased	kg/km
Mass per unit, greased	kg/km
DC Resistance at 20°C	NΩ/km
Coefficient of linear expansion	
Final modulus of elasticity	N/m^2
I^2t rating	A/s
Individual Wires	
Measurements made after stranding	
Resistivity at 20°C	NΩ/km
Minimum tensile strength of aluminium alloy /aluminium/copper	N
Minimum elongation at failure	%
Minimum load at 1% extension for steel wire	N
Minimum tensile strength of steel	N
Torsional ductility, number of turns to failure	

Minimum mass of zinc on galvanised steel wire	G/m²
Minimum mass of aluminium on aluminium clad steel wire	G/m²

D2.3.2 Sample Tests

Sample tests shall be made on 10% of the drums in a lot in accordance with EN 50182 except as modified. The mechanical tests on aluminium and aluminium alloy wires shall be taken on straightened samples of individual wires taken after conductor stranding. In the event of the sample from any length not passing the mechanical or resistivity tests, a second and third sample shall be taken from the same length, and if one of these also fails under test, the length of conductor from which it has been taken shall be rejected.

The measurement of wire diameter, conductor lay ratio and the tolerances shall be as defined in EN 50182. Steel strands for ACSR and AACSR shall be manufactured from regular grade steel and coated with zinc by the hot dip process according to classification ST1A in EN 50182. The torsion test for steel wires shall be performed.

A 1000mm length of conductor shall be cut from the end of the drum and dismantled to inspect the internal surfaces and for measuring the mass of grease.

D2.3.3 Routine Tests

All drums of conductor shall be inspected for traces of visible grease on the surface of the outer layer and for external strands, which are excessively loose or tight or show surface damage, which could generate corona at 400 kV. No wire shall protrude above the adjacent wire by more than 2mm.

D2.4 Additional Characteristics for Transport and Packing

D2.4.1 Drums

All overhead line conductors shall be supplied on wood or metal drums. Wooden drums shall be made of wood from sustainable forests, metal drums shall have the ability to be flat packed to reduce transport logistic costs, both shall be suitable for the length of conductor and all likely conditions of storage. The drums shall be designed to take a round spindle and be lagged to protect the conductor, whilst on the drums, from the risk of damage during transportation and handling on site. The inner end of the conductor projecting from the drum shall be secured and protected to avoid damage. The outer end of the conductor shall be secured to the inner face of one flange. Each drum shall bear a distinguishing number either branded or chiselled on the outside of one flange. The direction of rolling shall also be indicated. All covered conductors shall be sealed at both ends to prevent the ingress of moisture.

D2.4.2 Protection

The Supplier shall ensure that each item is suitably protected and packaged to maintain it "fit for service" prior to installation. Drums shall be lagged using weatherproof wood fibreboard (an example of this is Nolco-flex) to provide suitable protection to the conductor and secured with a circumferential banding system. Drums with battens nailed to the flanges are not acceptable. Conductors shall not be covered with any secondary protection such as water resistant paper.

D2.5 Influence of the Product on the Environment

D2.5.1 Embodied Carbon

Where available, the tenderer shall provide Environmental Product Declarations aligned to ISO 14025:2006 for significant materials streams and products. The tenderer shall use the UK Government GHG Conversion Factors for Company Reporting under Scope 3 (other indirect) emissions, material use and waste disposal to calculate the embodied carbon dioxide equivalent (CO2e) in kilograms (or tonnes) per tonne of material within the product and packaging, splitting by different material.

D2.5.2 Supply Chain Sustainability Knowledge

The tenderer shall agree at the time of tender to register as members of the Supply Chain Sustainability School at commencement of the contract and undertake training requested by SPEN. Free registration and membership can be obtained using the following link https://www.supplychainschool.co.uk/ . SPEN's Sustainability team shall confirm training expectations (Learning Pathways) to be undertaken through the Supply Chain Sustainability School by the supplier at the time of tender.

D2.5.3 Periodic Reporting

SPEN are improving supplier reporting through the use of the Smartwaste tool and the successful tenderer will be required to provide monthly reports on sustainability aspects and environmental compliance requirements directly related to contract delivery. The tenderer shall agree at the time of tender that monthly reports will be submitted through the Smartwaste tool. SPEN's Sustainability team shall provide further information regarding the Smartwaste tool at the time of tender.

ANNEX D3: AVANGRID

D3.1 Technical requirements

D3.1.1 General

All conductor material shown in ANNEX A.3 shall be provided by the Vendor.

The Vendor shall provide the stress-strain coefficients, and any other data required by the Southwire SAG10 program and the Power Line Systems (PLS-CADD) program for the conductor to be supplied.

Any substitutions or modifications to the ASTM specifications referenced herein shall have prior approval from AVANGRID Electric Network Standards.

D3.1.2 Material

For all materials, processes or details proposed by Vendor, as being "equal" to that specified, Vendor is to submit details as a submittal for review and approval by the Owner, which shall not necessarily be forthcoming.

The ACSR conductor material shall conform to the American Society for Testing Materials Designation 1350-H19 for aluminum ASTM B230 and for steel stranding ASTM B500.

The ACSR conductor shall be Class AA stranding in accordance with Table 1 of ASTM B232.

The ACSR aluminum wire shall be made of 1350-H19 aluminum alloy in accordance with ASTM B230. The minimum average conductivity of the aluminum shall not be less than 61.2% IACS at 20°C.

The zinc-coated (galvanized) steel core wire (Class A weight coating) shall be in accordance with ASTM B498. The minimum average conductivity of the steel shall not be less than 8% IACS at 20°C.

The ACAR aluminum shall be made of 1350-H19 aluminum alloy in accordance with ASTM B230 and 6201-T81 aluminum alloy in accordance with ASTM B399. The ACAR conductor shall be in accordance with ASTM B524.

The ACSS conductor listed in ANNEX D3 shall conform to ASTM B856. All AAAC conductor listed in ANNEX D3 shall conform to ASTM B399. All AAC conductor listed in ANNEX D3 shall conform to ASTM 231.

The bare copper conductors shall be in accordance with ASTM B1, ASTM B2, ASTM B3, and ASTM B8.

D3.2 Fabrication

D3.2.1 General

All work, work methods, workmanship and finish shall be equal to the best modern practice in the manufacture and fabrication of materials of the types covered by these Specifications. All work shall be carefully and accurately performed.

The Vendor shall identify, by submittal, the location of the facilities where the conductor is to be fabricated. The Vendor shall give written notice of the start of fabrication to the Owner sufficiently in advance to permit arrangements to be made for inspection of facilities, materials, and fabrication methods by the Owner or its representative.

The conductor shall be capable of withstanding normal handling incident to manufacture, shipment, and field installation without being deformed or abraded. Such handling includes reeling, lifting, and movement of all reels, unreeling, pulling through controlled tension stringing equipment, at stringing sheaves, compression fittings and other standard accessories as required.

D3.2.2 Finish

The surface of the strands shall remain smooth, free from points, sharp edges, abrasions, or other departures from smoothness that would tend to increase radio interference and corona loss. The conductor shall be free from excessive amounts of grease, metal particles, dirt, or other foreign matter.

The conductor shall not deform from cylindrical form nor shall longitudinal smoothness be affected by strand movement when subject to tension. Strands shall be formed so that there is no slack in the outer layer.

D3.3 Delivery

D3.3.1 Packaging and Marking

Reels shall be returnable metal (RMT) with ”I” beam flanges or wooden nonreturnable (NR), as specified in Annex A3. Reel sizes shall be as listed in ANNEX A3, unless requested otherwise.

Each reel/coil shall be one (1) continuous run of wire. Splices are not acceptable in any reel length.

Wood lagging or other suitable wrapping, NEMA WC26 Level 3 or better, shall be furnished on reels to protect conductors against damage. The wrapping or any cushioning material used on the inner flanges or drum shall be non-absorbent and shall not contribute to conductor damage whether wet or dry. When wood lagging is used, a layer of paper or other suitable material shall be wrapped around the conductor inside the lagging.

The wire end nearest the drum shall be attached securely to the metal reel flange.

The first coil of conductor shall be laid tightly on the drum and snugly against the reel flange and each succeeding coil shall be snugly and tightly laid against its neighbor until the layer is complete and the last coil in the layer fits snugly against the outer flange of the reel so there will be no tendency for the conductor to jam into lower layers when being paid off the reel under a tension of five hundred (500) pounds,

Arrows shall be painted on both outside surfaces of the flanges of each reel to indicate the direction in which the reel will rotate during unreeling of the conductor.

Securely attached to the outer surface of the reel flange shall be a tag indicating the following information. The tag shall be made of adequate material to ensure that the tag and lettering on it will remain legible for a period of three years. Lettering shall be a minimum of 3/16” in height.

a) Vendor’s Name
b) The description of the Conductor (size, stranding, material).
c) The production date.
d) The gross weight of the reel.
e) The net weight of the conductor on the reel.
f) The tare weight of lagging on the reel.
g) The length of wire on the reel.

h) The number of the reel.

i) The purchase order or contract number.

j) Vendor's Name, Address and Contact Telephone Number

k) Production test number.

l) Conductor tension balance test results.

m) The destination (storage yard) of the reel.

D3.3.2 Shipping

The conductor reels shall be shipped upright by the most appropriate means to the point(s) of delivery. All applicable federal and state laws, permits, rules, and regulations shall be followed. All shipments shall be by traceable means, so that the Vendor is able to locate in-transit materials at all times until said shipments are received and signed for by the Owner.

The Vendor shall adequately protect all shipments against damage in transit.

The conductor shall be delivered in a logical sequence to facilitate an orderly process of receiving and unloading at the point(s) of delivery. The Vendor shall notify the Owner when a portion of the order is ready for shipment. Written release by the Owner is required prior to the shipment. The Vendor shall notify the Owner seventy-two (72) hours prior to the anticipated delivery. The reels shall be shipped and delivered to the site in open trailers. Shipments in closed containers will not be accepted.

Unloading will be the responsibility of the Owner. For shipments by rail, the Owner will accept responsibility to unload from railroad cars only where the rail siding is adjacent to the point of delivery. Otherwise, the Vendor is responsible for transportation of the shipment between the railroad car and the point of delivery.

Upon delivery to the point of delivery, undamaged and intact reels will be accepted with cursory inspection of the contents. If damaged conductor is discovered upon inspection of the reels, the Vendor will be notified and the damaged conductor will be replaced by the Vendor.

D3.4 Source Quality Control

D3.4.1 Inspection

All materials furnished and all work performed shall be subject to inspection. Owner shall have entry, at all times while work is being carried on, to all parts of the Vendor's plant which concerns the work. The Vendor shall afford the Owner and its representatives (including third party inspectors) adequate documentation, to satisfy them that the materials are being furnished strictly in accordance with this Specification.

The Vendor shall afford the Owner and its representatives reasonable facilities to allow verification that the finished products and materials being furnished are in accordance with the requirements of this Specification.

No material shall be shipped until inspection at the Vendor's plant has been made or waived and certified copies of reports of tests and analyses have been approved through the submittal process. Waiving of inspection and release of material shall not relieve the Vendor from the responsibility for furnishing material that conforms to the requirements of these Specifications, or invalidate any claim which the Owner may make because of defective or unsatisfactory material and workmanship. Any material that is rejected shall be promptly replaced by the Vendor.

Inspection of materials at the Vendor's shop may be made to determine compliance with these Specifications. Acceptance of material at the Vendor's shop does not relieve the Vendor from compliance with all Specifications.

D3.4.2 Verification of Performance

1. Testing

   Factory tests, including tension and quality conformance tests, shall be made in accordance with the latest revisions in ASTM B230, B231, B232, B398, B399, B498, B609, B524, and B856 unless agreed to otherwise by the Owner, in writing.

   The timing, sample sizes, and frequency of inspections and tests shall be in accordance with industry standards unless otherwise specified.

   All tests at the factory, as specified to verify adequacy of raw materials, components and complete product to meet Specifications, shall be made or undertaken by the Vendor, and the Vendor shall furnish all test specimens, apparatus and instruments required for the purpose. The Owner reserves the right to witness any or all tests.

   The Owner reserves the right to examine the records of the Vendor to assure itself that the quality control procedures are adequate and being followed. Records shall be made available for a minimum of three (3) years following award of this Contract.

2. Test Reports

   The manufacturer shall submit test reports for all conductor manufactured in accordance with this specification. These reports shall be furnished for each wire size. Test reports may also be submitted electronically, in lieu of hard copy submittals. The following tests reports and certified documents shall be available to the Owner:

   1. Stranded diameters and tolerances.
   2. Stranded rated breaking strength.
   3. Strand elongation.
   4. Strand conductivity.
   5. For each layer, the values and tolerances of:
      a. Diameter over layer in inches.
      b. Length of lay in inches.
      c. Lay in terms of diameter.
      d. Direction of lay.

   The following tests shall be preformed for each 500,000 feet of conductor produced:

   6. The cross-sectional area of aluminum shall be determined.
   7. The ultimate tensile strength of the conductor shall be provided, and shall meet the requirements of ASTM B231, B232, B399, B424, or B856.
   8. The conductor diameter shall be determined while the conductor is subjected to a tension equal to 50% of the rated tensile strength. The measured diameter shall not be less than 99% nor more than 101% of the “outside diameter” listed in ANNEX A.3.

3. Independent Tests

The Owner reserves the right to obtain, from any lot of material being fabricated or supplied, samples or sample coupons for independent testing by a laboratory selected by the Owner, approved by the ASTM, and to reject any lot of material for which such tests fail to meet the Specification requirements.

ANNEX D4: NEOENERGIA

D4.1 Material

D4.1.1 Aluminum wires

The aluminum wires for AAC and ACSR cables shall be of type 1350, H19 temper and meet the dimensional, mechanical and electrical requirements as specified in NBR 5118.

D4.1.2 Aluminum alloy wires

The aluminum alloy wires for AAAC cables shall be from Aluminum-magnesium-silicon (6201) alloy, T81 temper and meet the dimensional, mechanical and electrical requirements as specified in NBR 5285.

D4.1.3 Copper wires

The Copper wires for bare copper conductors shall be in soft or Medium-Hard drawn temper, according to the Annex A4, and meet the dimensional, mechanical and electrical requirements as specified in NBR 5111.

D4.1.4 Steel wires for ACSR Cables

Steel wires for ACSR cables must be supplied with zinc coating hot dip class A and meet the requirements prescribed in NBR 6756. The steel wires must have continuous zinc and uniform thickness layer, smooth surface without imperfections that compromise performance.

Aluminum-clad steel wires also are acceptable, once the whole conductor is in accordance with ABNT NBR 10841.

D4.1.5 Copper Clad Steel Wires

The copper clad steel wires shall meet the dimensional, mechanical and electrical requirements as specified in NBR 8120.

D4.1.6 Copper Clad Steel Stranded Wires

The copper clad steel stranded wires shall meet the dimensional, mechanical and electrical requirements as specified in NBR 8121.

D4.2 Tolerance

As indicated in reference standards.

D4.3 Identification

The reels shall be marked on the two outer side faces, directly on the disc or by means of a metal plate, with legible and indelible characters, with at least the following indications:

- Name or trade mark of the manufacturer
- The name of the company purchaser (Coelba, Cosern, Elektro, Neoenergia Pernambuco or Neoenergia Distribuição Brasília)
- ABNT applicable
- Complete cable identification (type of conductor; international code; nominal section in square millimeters or AWG / MCM; number of aluminum, copper or steel wires; stranding class; Temper)
- Zink Class (When applicable)

- IACS Conductivity (applied for copper clad steel conductors)
- Purchase Order Number
- Serial number of the reel
- Gross and net weight (kg)
- Length of the conductor in meters
- Indicative arrow with the cable winding direction
- Month and year of manufacture
- Dimension of the reel
- Other information that the application requires.

Note 1:

a) The labels shall be weatherproof, encapsulated in transparent plastic and support a minimum of two years of storage reels to time.

b) The supplier shall number the various reels and attach them to invoice a descriptive relation of the individual contents of each.

c) The indicative arrow indicating the direction of unwinding must be marked on the side discs in high or low relief.

D4.4 Packaging

Cables shall be arranged as to be protected during handling, transport, storage and be in accordance with ABNT NBR 7310. The reels shall meet the dimensional according to NBR 11137 and the rollers according to NBR 7312.

D4.5 Finish

The cable must meet uniform surface finish free of cracks, burrs, roughness, striations, inclusions, scales, stringing holes or other defects that compromise product performance.

D4.6 Testing requirements

- Aluminum Wires shall be tested as detailed in NBR 5118
- ACSR Conductors with zinc coated steel wires shall be tested as detailed in NBR 7270.
- ACSR Conductors with aluminum-clad steel wires shall be tested as detailed in NBR 10841.
- AAC Conductors shall be tested as detailed in NBR 7271.
- AAAC Conductors shall be tested as detailed in NBR 10298.
- Soft Drawn Copper wires shall be tested as detailed in NBR 5111.
- Medium Hard Drawn Copper conductors shall be tested as detailed in NBR 6524.
- Copper Clad Steel Wires shall be tested as detailed in NBR 8120.
- Copper Clad Steel Stranded Wires shall be tested as detailed in NBR 8121.

All conductors shall have a test report detailing the results of the tests with the application for product qualification.

The Manufacturer also shall to provide reports of the tests prescribed by standards NBR 5111, NBR 5118, NBR 5285, NBR 6756, NBR 15957 and NBR 8120.

D4.7 Other conditions

Other conditions shall be observed in NBR 5118 for Aluminum wires, NBR 7270 and NBR 10841 for ACSR conductors, NBR 7271 for AAC conductors, NBR 10298 for AAAC conductors, NBR 5111 and NBR 6524 for Copper conductors, NBR 8120 for Copper Clad Steel Wires, NBR 8121 for Copper Clad Steel Stranded Wires and referenced standards.

D4.8 Warranty

The manufacturer shall provide 24 months warranty from the date of issue of the invoice or 18 months from the start of use, whichever occurs first, against any defect in materials, manufacturing and packaging of the supplied cables, according with the requirements of this standard.

If the product supplied is defective or fails to meet the requirements presented by NEOENERGIA, a new 12 months of successful operation warranty period shall enter into force for the batch in question.

The guarantee must cover the replacement of any cable be defective due to any shortcomings in its design, raw material and workmanship for the duration of this period, expenses hand labor arising from removal and installation of cables, prove to be defective manufacturing, and transport between the warehouse and manufacturer occur on account of the latter.

ANNEX E: INFORMATION TO BE PROVIDED BY THE SUPPLIER

The Tenderer is required to complete the schedules attached to this Specification, including all the appropriate information in respect of each item offered.

The Tenderer shall return the following additional documentation with copies of the completed Schedules at the time of tendering:

The Tenderer shall submit the following conductor details for each conductor:

Table E.1: Data sheet for overhead conductors

Nº	Description	Unit	Data
000	Designation / Reference		
001	Manufacturer Reference		
	Mechanical Features		
002	Conductor type	-	
003	*Core Features (if reinforced)*		
003.1	Core Type	-	
003.2	Material (type and coat if required)	-	
003.3	Wire, number and diameter (if stranded)	Qty / mm	
003.4	Layer number	Qty	
003.5	Strand compliant with Standard	-	
003.6	Core external diameter	mm	
003.7	Core effective area	mm²	
003.8	Core weight per unit length	kg/km	
004	*Outer Conductor Features*		
004.1	Conductor type	-	
004.2	Material	-	
004.3	Wire, number and diameter (if stranded)	Qty / mm	
004.4	Layer number	Qty	
004.5	Strand compliant with Standard	-	
004.6	Conductor area	mm²	
004.7	Outer Conductor weight per unit length	kg/km	
005	Overall conductor diameter	mm	
006	Complete cable area	mm²	
007	Total mass per unit length	kg/km	
008	Grease type and application	-	
009	Mass of Grease	kg/km	
010	Lower temperature of Grease	ºC	
011	Maximum temperature of Grease	ºC	

Table E.1: Data sheet for overhead conductors			
Nº	**Description**	**Unit**	**Data**
012	Direction of lay, outer layer	Z or S	
013	Ultimate Tensile Strength of Conductor	kg	
014	Modulus of elasticity (Global)	N/mm²	
015	Linear expansion coefficient (Global)	/ºC	
016	Polynomial Coefficients as described in *McDonald, B. and Peyrot, A. (1990). "Sag-Tension Calculations Valid for Any Line Geometry." J. Struct. Eng., 116(9), 2374–2386. TECHNICAL PAPERS (see NOTE below)*		
016.1	*Outer Strands*		
016.1.1	Modulus of elasticity	N/mm²	
016.1.2	Thermal expansion coefficient	/ºC	
016.1.3	a0 Stress - Strain	N/mm²	
016.1.4	a1 Stress - Strain	N/mm²	
016.1.5	a2 Stress - Strain	N/mm²	
016.1.6	a3 Stress - Strain	N/mm²	
016.1.7	a4 Stress - Strain	N/mm²	
016.1.8	c0 Creep	N/mm²	
016.1.9	c1 Creep	N/mm²	
016.1.10	c2 Creep	N/mm²	
016.1.11	c3 Creep	N/mm²	
016.1.12	c4 Creep	N/mm²	
016.2	*Core strands*		
016.2.1	Modulus of elasticity	N/mm²	
016.2.2	Thermal expansion coefficient	/ºC	
016.2.3	b0 Stress - Strain	N/mm²	
016.2.4	b1 Stress - Strain	N/mm²	
016.2.5	b2 Stress - Strain	N/mm²	
016.2.6	b3 Stress - Strain	N/mm²	
016.2.7	b4 Stress - Strain	N/mm²	
016.2.8	d0 Creep	N/mm²	
016.2.9	d1 Creep	N/mm²	
016.2.10	d2 Creep	N/mm²	
016.2.11	d3 Creep	N/mm²	
016.2.12	d4 Creep	N/mm²	
NOTE:	All coefficients in Data nº 16 can be determined by curve fitting of experimental data according to next equation:		
	$\sigma = k_0 + k_1 \varepsilon + k_2 \varepsilon^2 + k_3 \varepsilon^3 + k_4 \varepsilon^4$		
	Electrical Features		
017	Maximum DC resistance at 20ºC	ohm/km	
018	Maximum AC resistance at 25ºC	ohm/km	

Table E.1: Data sheet for overhead conductors			
Nº	**Description**	**Unit**	**Data**
019	Maximum AC resistance at 75ºC	ohm/km	
020	Rated current @ maximum operating temperature	A	
021	Maximum operating temperature (steady state)	ºC	
022	Maximum operating temperature (irreversible damage)	ºC	
	Cable packaging		
023	Drum Type	-	
024	Inside Drum Diameter	m	
025	Outside Drum Diameter	m	
026	Drum Width	m	
027	Empty Drum Weight	kg	
028	Estimated conductor Length in drum	km	
029	Filled Drum Weight	kg	

ANNEX F: HEALTH AND SAFETY

F1.1 Manual and selection of conductors

F1.1.1 Recommendations for use

Conductors according to this rule are used to the weather, on structures fixed installations.

F1.2 Recommendations for storage and transport

F1.2.1 Expedition

The conductors should be protected to prevent damage during storage and transport. Special care will be taken to prevent nails, screws, etc., Used in the manufacture of the coil, or in fixing the protective coating, may cause damage to the conductor.

F1.2.2 Transport

For transportation of filled wire coils should be used only suitable carriers. The filled wire coils only be transported with its axis horizontal. Will prevent any movement of the coil. Loading and unloading is affected by appropriate means to prevent damage to the wires and coils.

The coils filled conductor will be shot only over short distances on flat, solid and only to the address on the conductor reel. The conductor ends are firmly attached.

F1.3 Recommendations for stringing conductors and installing

F1.3.1 Stringing and operating conditions

The conductors will be stringed and operated such that their characteristics do not deteriorate. In this context, we shall consider the following points:

- Operating conditions, such as concentration of conductors installed, influence of external sources of heat, solar radiation, etc.
- Method of stringing.
- Adverse external influences.
- Potential attack fauna and flora.

When conductors are installed with tensile stress, for example from pole to pole, suitable mooring be used.

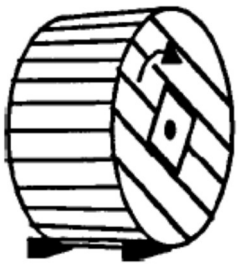
F1.3.2 Stringing

- Care is taken to string the appropriate choice of the sheave for the conductor, in order not to exceed the minimum bend radius. The pulling force is continuously monitored during the stringing and sagging process and care should be taken not to damage the conductor during installation.
- The tensile stress is usually transmitted by a stocking or come-along clamp, using the frictional contact between the sleeve and conductor. It is recommended not to exceed the maximum effort contained in the installation specifications.

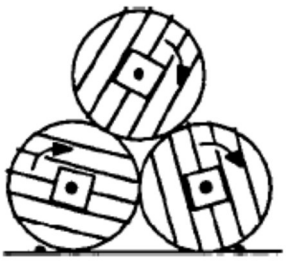
F1.4 Other Recommendations

STORAGE

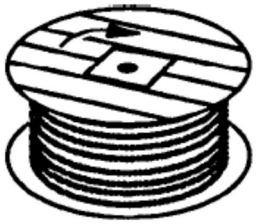
Maintaining coil upright, placing shims in the bottom of the dishes or by other suitable means



Only coils with a protective coating can be stacked plate resting on plate
Should be put on the coils properly extreme of the previous row

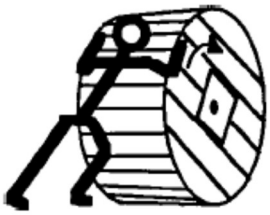


Never leave the coil supported by the flat plate

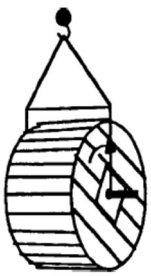


TRANSPORT

Rolling the coil in the address used during winding of the conductor

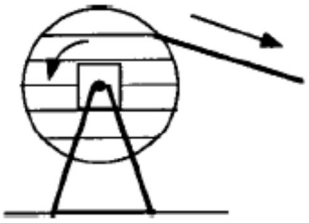


The coils should always be handled with cranes or forklifts



UNWINDING

Unwinding in this sense

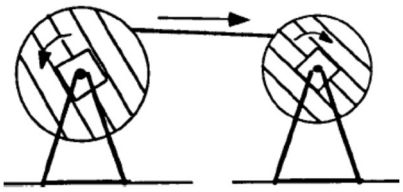


The rolls must be unrolled in this manner, according to the manufacturer's recommendations

Thus unwinding never

REWIND

Recommended



Not recommended