INDEPENDENT POWER TRANSMISSION OPERATOR S.A.

TRANSMISSION NEW PROJECTS DEPARTMENT

TRANSMISSION LINES EQUIPMENT ELECTRICAL DESIGN AND CABLES ENGINEERING SECTION

SPECIFICATION TR - 2

ALUMINUM CONDUCTORS STEEL REINFORCED

Revision July 2012

ATHENS - GREECE

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1. SCOPE

This specification covers the design, manufacturing and testing of concentric lay stranded phase conductors, made from round hard drawn aluminum wires and steel wires, which are used as overhead electrical conductors at 150kV, 400kV T.L. and connections of equipment in EHV Substations. At 150kV T.L. is used only one conductor per phase and at 400kV T.L. is used a bundle of two or three conductors per phase.

2. GENERAL REQUIREMENTS

Phase conductors are ACSR, AACSR and Alumoweld type. Code name of ACSR phase conductors are LINNET 336400 CM and GROSBEAK 636000 CM for 150kV T.L., CARDINAL 954000 CM for 400kV T.L. and 550/70 (acc.EN 50182-2001) for EHV Substations. Respectively code names of Alumoweld type phase conductors are LINNET/AW and GROSBEAK/AW. Reinforced phase conductors are AACSR type and they are distinguished to light and heavy conductor.
Manufacturing and characteristics of conductors and their wires shall meet the requirements of International Standards IEC 61089, Amendment of IEC 61089 – am1/97 and IEC 61232/93, when applied and don't conflict with the requirements of this specification. The quality of the conductors during the manufacturing process will be verified by standard EN ISO 9001.

2.1 Technical characteristics

2.1.1 ACSR phase conductors are made of concentric lay stranded hard drawn aluminum wires and round zinc coated steel core wires. The type of zinc coating shall be standard weight. The quality of aluminium wires shall be 1350–H19 (conductivity 61.2% IACS – International Annealed Copper Standard).

2.1.2 Reinforced phase conductors AACSR (A2/S1A) type are made of concentric lay stranded ALMELEC wires, aluminum alloy with 0.6% Si and 0.7% Mg and round zinc coated steel, type R, core wires. Geometrical data of ALMELEC and steel wires are the same with corresponding aluminum and steel wires of ACSR LINNET and GROSBEAK conductors. ALMELEC wires have tensile strength 33kg/mm^2 and type R steel wires have tensile strength 160kg/mm^2.

2.1.3 Alumoweld type phase conductors are made of concentric lay stranded aluminum wires and round aluminum clad steel core wires. The aluminium clad steel wires shall be class 20SA and type A, with conductivity 20.3% IACS (International Annealed Copper Standard).

2.1.4 All the internal layers of conductors should contain proper lubricant according to Case 2 of Annex C of International Standard IEC 61089. The lubricant shall be pure and neutral to the material of the conductor's wires. The lubricant's pour point shall be not less than 75°.

2.1.5 Technical characteristics of phase conductors shall meet the requirements of Annexes

A, B, C, D or E.

2.2 Material

All the wires should have, before stranding, characteristics that meet the requirements of paragraph 5.1 of International Standard IEC 61089 and its Amendement (IEC 61089 – am1/97).

2.3 Stranding – Joints

Stranding and joints of aluminum and steel wires shall meet the requirements of paragraphs 5.4 and 5.5 of International Standard IEC 61089 and its Amendement (IEC 61089 – am1/97). The specified direction of lay of the external layer shall be "right – hand".

2.4 Length of each section

The specified "standard reel length" is approximate. The accepted tolerance is ±5%. No more than 5% of the total weight of conductor may be furnished in random lengths, none of which shall be less than 65% of the standard reel length. It is not allowed a random length to be wound on the same reel with a standard length. The manufacture of standard conductor length shall be continuous.
The specified standard reel length may be changed by approval or commission of the Company.

2.5 Reels

2.5.1 The conductor will be packed in wooden reels, designed in such a way so the conductor is properly protected from damages during transportation (sea, rail, road, air), moving or storing it outdoors.

2.5.2 Reels shall be made from dry pine or fir wood. The wood humidity before reels manufacturing has to vary between 15-25%. Wood quality and its humidity will be proved either by measurements using special electronic devices or by the relevant reports and wood Supplier's shipping invoices. The reels will be brand-new, they must not be used and their surfaces have to be frictionless, without any flakes or holes or generally any inkling of insects presence.

2.5.3 Reel heads shall be firmly bolted to the drum and shall be equipped with a cast iron hub bushing with a hole at the center of the head. Reels shall be lagged with wood lagging, so that the outer layer of the conductor to be protected. In addition the reels shall have a layer of water proof paper around the drum and around the conductor lies inside the lagging and also on the inner surface of the reel heads. Special attention shall be taken during the winding of the conductor to the reel, so that the conductor is properly placed in order to avoid friction between the lays of the conductor during transportation.
The connection of the wooden parts of the reel shall be done in such a manner so that the conductor won't be scratched or afflicted, such as staples, while the use of nails shall be avoided. The outer surface of the reels shall be properly painted in order to protect the reel from humidity and to characterize each type of conductor.

2.5.4 The winding of the conductor on the reel has to be uniform and in accordance with the rules of art, the conductor layers have to be distinguished, the layer level must keep order and the phenomenon of "straddled" conductors must not appear. For this reason Manufacturer has to pay high attention to the winding during conductor fabrication from the very first layer, which is of highest importance, so that the conductor spires are strictly the one beside the other, without leaving any spaces for all along the reel length and continue in the same way

for all layers.

2.5.5 The correspondence between drum's colour and conductor's type is:

Type of conductor	**Colour**
- ACSR Linnet	Red
- ACSR Grosbeak	Blue
- ACSR Cardinal	Yellow
- ACSR 550/70	Turquoise
- Linnet/AW	White
- Grosbeak/AW	Green
- Reinforced light conductor AACSR	Orange
- Reinforced heavy conductor AACSR	Grey
- Reinforced conductor of 400kV T.L.	Brown

The drawing of the reel shall meet the requirements of drawing TR – 2/1 of IPTO S.A.

2.6 Marking

2.6.1 On a tablet or label, properly attached at the edge of the conductor, the following data will be marked:

- Type of conductor,
- Mixed and net weight,
- Length,
- Size,
- lay characteristics,

and every other characteristic that the manufacturer consider necessary.

2.6.2 The data of the marking described in paragraph 2.6.1 of present specification, the ordering number, the series number of the manufacturer (if there is any) and the shipment data shall be marked on the outer surface of the wooden drum.

3. TESTS

All required tests should be preformed in proper independent laboratories accredited according to International Standard ISO/IEC 17025. Test reports have to be written in Greek or English language, clear–sighted and certified by the laboratory where the tests have taken place. The tests shall be in accordance with the paragraph 6 of International Standard IEC 61089, where applicable and don't confront with the requirements of present specification. In cases of wires shall be according to corresponding International Standards IEC 60104, IEC 60888, IEC 60889 and IEC 61232.
Especially sample and routine tests can be performed to manufacturer's laboratory if it's certified by ISO 9001.

3.1 Test samples

The size and length of the samples shall be according to the corresponding paragraphs of International Standards IEC 61089, IEC 60888, IEC 60889 and IEC 61232.
Samples of wires shall be taken after stranding, will be cut in presence of the Company's representative and will be hand over to him for the prosecuting of the tests.

3.2 Type tests

Type tests shall comply with the requirements of paragraphs 6.2.1 and 6.5 of International Standard IEC 61089. The tests for evaluating the breaking strength of the complete conductor shall be done according to the Company's instructions and only if Company considers it expedient.

3.3 Sample tests

Sample tests shall comply with the requirements of paragraph 6.2.2 of International Standard IEC 61089.
In case of wires for AACSR type phase conductor, the tensile strength shall be equal with the specified value in paragraph 2.1.2 of present specification.

4. INSPECTION

4.1 The conductors shall be subjected to inspection and shall not be released for shipping without the approval of the Company's representative. The approval for shipping shall neither relieve the Manufacturer from responsibility of furnishing material conforming to all requirements of the Company nor invalidate any claim which the Company may make because of defective or unsatisfactory material.

4.2 Manufacturer shall submit to the Company copies of the control and test reports of the material. The Company reserves the right to demand all the routine test reports from the manufacturer.

4.3 In each delivery quantity, sample tests shall be performed in accordance with the requirements of paragraph 3.3 of present specification.

4.4 For type test reports that haven't been submitted or that aren't adequate according to the requirements of paragraph 3 of present specification, IPTO reserves the right to request the performance of any or all type tests specified in paragraph 3.2 of present specification on samples which shall be taken from the production of the offered items. The Company reserves the right to select test laboratory and witness any or all tests.

4.5 Purchaser has the right, with his own expenses, to pick up a proper length of any part which is delivered from the manufacturer, according to present specification, and give them to a proper independent accredited laboratory of his choice (Purchaser's), for the certification of tests or characteristics or for additional research and tests which will be judged necessary from the purchaser.

4.6 In order to check the correct conductor winding during inspection, it will be performed the "Test for ability of a conductor to be erected using tension stringing", which is referred to Annex E of EN 50182:2001 "Conductors for overheads lines – Round wire concentric lay stranded conductors". Test sampling will be according to ISO 2859-1, General Inspection Level I, AQL 4.0 – Normal inspection.
In case of failure during this test, the batch will be rejected and manufacturer has to rewind all the batch reels and test will be repeated. In this case the Company reserves the right to retest with sampling according to ISO 2859-1, General Inspection Level I, AQL 4.0 – Tightened inspection.
If this test is not possible to be performed in Manufacturer's plant, he will be obliged to rewind all reels which IPTO' s inspector considers that don't meet the requirements of paragraph 2.5.4 of present specification.

4.7 All Bidders shall have to state the manufacturers of the material, as well as all related sub-contractors, if any.
They shall also have to submit along with their offer a Quality Assurance Plan (Q.A.P), for the manufacturing procedure of the stated manufacturer and all potential sub-contractors, by which it shall be evident in a detailed way the entire manufacturing procedure, the quality control equipment as well as all quality control stages, including all of the related printed material and referring to the specific international standards and regulations applied.
During the Technical Evaluation procedure, IPTO shall reserve itself the right to monitor the

production procedure so as to ascertain the application of the Q.A.P. and, in general, to conclude on the production procedure, in a way that shall deem the offer technically acceptable or not.

4.8 Manufacturer is responsible for the conductor behaviour during installation at the T.L.

5. DATA TO BE SUBMITTED WITH OFFER

In the offers must be included the following data in a clear and unique way. In any case that the following data are missing or they don't comply with the following the offers will be rejected.

5.1 Detailed drawing of the reels from manufacturer, with all details and basic dimensions in scale, for each type of conductor. The drawing will be submitted from manufacturer for approval.

5.2 Technical characteristics of the conductors according to the data given in Annex A, B, C, D or E which shall be confirmed by the manufacturer at the corresponding columns.

5.3 Description of the manufacturing process shall be given. A quality assurance program (EN ISO 9001) for the factory, in order to verify the quality of the offered materials during the manufacturing process. Also manufacturer/supplier must submit the place that each fitting will be manufactured.

5.4 A reference list of at least three (3) Electrical Companies for quantity equal at least with the quantity of inquiry for each type of conductor, which have been installed and are in satisfactory operation, with no problems, for the last five (5) years.
The installation and satisfactory operation of the offered material shall be accompanied by corresponding certificates of the Users (Electrical Companies), in which there shall be cited the type of conductor, date of selling, installation date, exactly quantity and the operation voltage.
Certificates shall be original or validated copies and distinct regarding the Electrical Company that edit and guarantee the excellent operation of corresponding material.
IPTO reserves the right to accept offers with reference list less than three (3) Electrical Companies, as long as the quantities and the purchaser are taken into account.
Bidders that have supplied in the last decade, IPTO or PPC with the requested material, have no obligation of submitting the prerequisites of paragraphs 5.3 and 5.4, provided that it does not change the factory of manufacture.

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Specification TR – 2

ANNEX A

ACSR CONDUCTOR DATA

DESCRIPTION		LINNET	Manufacturer data	GROSBEAK	Manufacturer data	CARDINAL	Manufacturer data
Aluminum Cross – section	MCM	336.4		636		954	
	mm²	170.55		321.84		484.53	
Maximum D.C. Resistance at 20° C	Ω/km	0.166		0.0877		0.0587	
Overall Diameter	mm	18.31		25.15		30.42	
Aluminum wires	mm	26×2.89		26×3.97		54×3.38	
Steel wires	mm	7×2.25		7×3.09		7×3.38	
Steel core diameter	mm	6.74		9.27		10.13	
Nominal weight	kg/km	690		1300		1830	
Minimum breaking strength	kN	65		115		150	
Standard reel length	m	3000		3000		2600	
Lengths per reel		1		1		1	

ANNEX B

DATA OF ALUMOWELD TYPE CONDUCTOR

Description		Light conductor	Manufacturer data	Heavy conductor	Manufacturer data
Aluminum Cross – section	MCM	336.4		636	
	mm²	170.55		321.84	
Maximum D.C. Resistance at 20° C	Ω/km	0.1607		0.0849	
Overall diameter	mm	18.31		25.15	
Aluminum wires	mm	26×2.89		26×3.97	
Steel wires	mm	7×2.25		7×3.09	
Steel core diameter	mm	6.74		9.27	
Nominal weight	kg/km	655		1240	
Minimum breaking strength	kN	60		110	
Standard reel length	m	3000		3000	
Lengths per reel		1		1	

Specification TR – 2

ANNEX C

REINFORCED PHASE CONDUCTORS DATA

ΠΕΡΙΓΡΑΦΗ		Light conductor	Manufacturer data	Heavy conductor	Manufacturer data
Overall diameter	mm	18.31		25.15	
ALMELEC wires	mm	26×2.89		26×3.97	
Steel wires	mm	7×2.25		7×3.09	
Steel core diameter	mm	6.74		9.27	
Nominal weight	kg/km	700		1300	
Minimum breaking strength	kN	90		170	
Standard reel length	m	3000		3000	
Lengths per reel		1		1	

ANNEX D

REINFORCED PHASE CONDUCTOR DATA FOR 400kV T.L.

Description		Reinforced conductor	Manufacturer data
Overall diameter	mm	56.20	
Aluminum wires	mm	150×3.75	
Steel wires	mm	37×2.68	
Nominal weight	kg/km	6270	
Minimum breaking strength	kN	530	
Standard reel length	m	1000	
Lengths per reel		1	

ANNEX E

ACSR CONDUCTOR DATA FOR EHV SUBSTATION

DESCRIPTION		**Conductor 550/70** acc. EN 50182	**Manufacturer data**
Aluminum Cross – section	mm²	550	
Maximum D.C. Resistance at 20° C	Ω/km	0.052	
Overall Diameter	mm	32.40	
Aluminum wires	mm	54×3.60	
Steel wires	mm	7×3.60	
Steel core diameter	mm	10.80	
Nominal weight	kg/km	2077.2	
Minimum breaking strength	kN	166.32	
Standard reel length *	m	1200	
Lengths per reel		1	

* **Note:** Dimensions of reel shall be adjusted to standard reel length of the conductor.