IEC 63190

Edition 1.0 2023-08

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Railway applications – Fixed installations – Electric traction – Copper and copper alloy catenary wires for overhead contact line systems

Applications ferroviaires – Installations fixes – Traction électrique – Câbles porteurs longitudinaux en cuivre et en alliage de cuivre destinés aux réseaux de lignes aériennes de contact

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RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRIC TRACTION – COPPER AND COPPER ALLOY CATENARY WIRES FOR OVERHEAD CONTACT LINE SYSTEMS

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The text of this International Standard is based on the following documents:

Draft	Report on voting
9/2973/FDIS	9/2994/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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- withdrawn,
- replaced by a revised edition, or
- amended.

RAILWAY APPLICATIONS – FIXED INSTALLATIONS – ELECTRIC TRACTION – COPPER AND COPPER ALLOY CATENARY WIRES FOR OVERHEAD CONTACT LINE SYSTEMS

1 Scope

This document specifies the characteristics of copper and copper alloy catenary wires for use on overhead contact lines.

This document also covers auxiliary catenary wires. It establishes the product characteristics, the test methods, checking procedures to be used with the catenary wires, together with packing, ordering and delivery conditions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60468, *Method of measurement of resistivity of metallic materials*

ISO 6892-1, *Metallic materials – Tensile testing – Part 1: Method of test at room temperature*

ISO 7801, *Metallic materials – Wire – Reverse bend test*

ISO 7802, *Metallic materials – Wire – Wrapping test*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
stranded conductor
conductor consisting of a number of individual uninsulated wires laid up together in left- and right-hand alternating helical layers

[SOURCE: IEC 60050-466:1990, 466-10-03]

3.2
catenary wire
messenger wire
longitudinal stranded conductor supporting the contact wire or wires either directly or indirectly

Note 1 to entry: The term "catenary wires" used in this document includes auxiliary catenary wires.

[SOURCE: IEC 60050-811:2017, 811-33-06, modified – In the definition, "cable" has been replaced with "stranded conductor". Note 1 to entry has been added.]

3.3
individual wire
one of the wires of a catenary wire

3.4
compacted catenary wire
catenary wire in which the interstices between the individual wires have been reduced by mechanical compression, or by drawing, or by suitable choice of the shape and disposition of individual wires

3.5
length of lay
axial length of one complete turn of the helix of a wire in a stranded conductor

[SOURCE: IEC 60050-466:1990, 466-10-05]

3.6
lay ratio
ratio of the length of lay to the outer diameter of the helix

[SOURCE: IEC 60050-466:1990, 466-10-06, modified – In the definition, "outer" has been added.]

3.7
measured wire diameter
diameter, determined from measurements

3.8
calculated cross-sectional area
sum of the cross-sectional areas of individual wires

3.9
nominal cross-sectional area
value used for designation purposes based on the calculated cross-sectional area rounded to the nearest multiple of 5 mm^2

Note 1 to entry: Regional exceptions exist.

3.10
direction of lay
direction of twist of a layer of wires of a stranded conductor as viewed from the end

Note 1 to entry: The lay is said to be right-hand when the visible portion of the helix, together with the two cross-sections limiting it, form the shape of a letter Z, and left-hand when they form the shape of a letter S, see Figure 1.

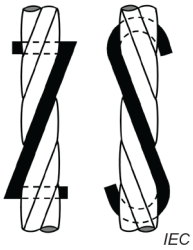

Figure 1 – Direction of lay

[SOURCE: IEC 60050-466:1990, 466-10-07, modified – Note 1 to entry from IEC 60050-461:2008, 461-04-03 and Figure 1 have been added.]

3.11
stranding factor
relative increased ratio in unit mass and electrical resistance due to stranding, dependent on the lay ratio

3.12
fill factor
ratio of the unit mass of the catenary wire to the unit mass of a rod made of the same length, diameter and material

4 Designation system

4.1 Material designation

The catenary wires, as described in this document, shall consist of a copper or copper alloy. The user shall specify explicitly the alloying material(s) to be used in the construction. Chemical composition, mechanical characteristics, conductivity class and % IACS shall be agreed between purchaser and supplier. Mechanical characteristics are designated C0 to C7, where C0 represents pure copper and C1 to C7 are designations given to represent characteristics of materials, which can be achieved with commonly used copper alloys worldwide. They have been grouped in Table 2 with increasing tensile strength so that shared mechanical characteristics are common within each category. Examples for some possible chemical compositions and some common conductor constructions of the copper and copper alloy catenary wire are presented in Annex B.

4.2 Catenary wire designation system

The catenary wire designation shall consist of:

– "Catenary wire" (as shown in the examples in Table 1, but not in Annex B or Annex E);
– reference of this document;
– nominal cross-sectional area;
– number of individual wires;
– individual wire diameter;
– conductivity class and % IACS conductivity (as per Table 3 and Table 4);
– mechanical characteristics (C0 to C7 as per Table 2);
– alloying elements.

The formatting of this combined designation system is shown in Table 1.

Table 1 – Example wire designations

Document reference		Nominal cross-sectional area		Number of individual wires		Individual wire diameter		Conductivity class and % IACS		Mechanical characteristics		Alloying elements
Catenary Wire IEC 63190-60-19x2,00-S96-C1 CuAg												
IEC 63190	-	60	-	19	x	2,00	-	S96	-	C1		CuAg
Catenary Wire IEC 63190-180-37x2,50-H59-C6 CuMg												
IEC 63190	-	180	-	37	x	2,50	-	H59	-	C6		CuMg

Further alloy compositions and example catenary wires are listed in Annex B.

5 Characteristics of catenary wires

5.1 Appearance and condition

The catenary wires shall not present any imperfections (roughness, sliver, seam, inclusion or cracks) liable to affect the mechanical and electrical properties specified in this document or to cause difficulties during installation and operation.

The surface shall be clean and free of oxide inclusions or sulphide generated during the manufacturing process or foreign substances such as pickling residue. Slight changes in the colour of the bright metallic surface due to atmospheric influence immediately after manufacturing are acceptable.

The catenary wire shall not have any crossings, protrusions, breaks, burrs, scratches, indentations, dents or cracks in accordance with good technical practice.

The catenary wire shall be coiled carefully in orderly layers on the drum. The two ends of the wire shall be fastened to the flanges of the drum. There shall be no twist or cross-over of turns within a layer or between layers in the winding.

5.2 Configuration, type, cross-sectional area and catenary wire sizes

5.2.1 General

The catenary wires are composed of a number of individual wires laid up together. Mechanical characteristics of typical individual wires are shown in Table 2, and electrical characteristics are shown in Table 3 and Table 4.

Table 5 details reference round wire concentric lay catenary wires. There are four different constructions with 7, 19, 37 and 61 individual wires. Each conductor is composed of a central individual wire surrounded by one or more adjacent layers of wires that are laid helically in opposite directions.

The measured wire diameter of the catenary wire shall not vary by more than:

- ±1 % for diameters larger than or equal to 10 mm;
- ±0,1 mm for diameters smaller than 10 mm.

Other designs can be allowed by agreement between purchaser and supplier, in accordance with 5.5.

Table 2 – Individual wire mechanical characteristics

Diameter mm	Minimum tensile strength (MPa) before stranding and after stranding, and reduction coefficient															
	Material															
	C0		C1		C2		C3		C4		C5		C6		C7	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
up to 1	430	409	430	409	490	466	520	494	620	589			736	714		
>1,00 to 1,25	430	409	430	409	490	466	520	494	620	589			736	714		
>1,25 to 1,50	430	409	430	409	490	466	520	494	620	589			718	696		
>1,50 to 1,75	430	409	430	409	490	466	520	494	620	589	697	679	718	696		
>1,75 to 2,00	430	409	430	409	490	466	520	494	620	589	660	640	697	676	776	760
>2,00 to 2,25	430	409	430	409	490	466	520	494	620	589	639	620	686	665	776	760
>2,25 to 2,50	430	409	430	409	490	466	520	494	620	589	622	603	652	641	750	735
>2,50 to 2,75	430	409	430	409	490	466	520	494	620	589	622	603	638	617	750	735
>2,75 to 3,00	430	409	430	409	490	466	520	494	620	589						
>3,00 to 3,25	424	402	424	402	485	460	520	494	620	589						
>3,25 to 3,50	424	402	424	402	485	460	500	475	600	570						
>3,50 to 3,75	418	397	418	397	479	455	500	475	600	570						
>3,75 to 4,00	418	397	418	397	479	455	500	475	600	570						
>4,00 to 4,25	413	392	413	392	474	450	500	475	600	570						
Reduction coefficient	95 %		95 %		95 %		95 %		95 %		97 %		97 %		98 %	
Heat resistance [a]	No		Yes		Yes		Yes		Yes		Yes		Yes		Yes	

[a] The heat resistance indicates whether the alloy resists changes in its physical properties when subjected to changes in temperature and if requested by purchaser shall comply with the test procedure in 6.13.

Table 3 – Individual wire electrical resistivity characteristics

Conductivity class	Maximum material resistivity (nΩm)							
	C0	C1	C2	C3	C4	C5	C6	C7
Standard (S)	17,77	17,96	24,63	25,73	27,78	31,35	57,47	66,30
High (H)			21,55	21,55	22,99	24,40	29,30	50,80
Extra High (E)			20,28	20,48	21,55	22,99	24,40	
Ultra High (U)			19,16	19,82	20,28	21,55	23,00	

Table 4 – Individual wire electrical conductivity characteristics

Conductivity class	Minimum material conductivity (% IACS)							
	C0	C1	C2	C3	C4	C5	C6	C7
Standard (S)	97	96	70	67	62	55	30	26
High (H)			80	80	75	71	59	34
Extra High (E)			85	84	80	75	71	
Ultra High (U)			90	87	85	80	75	

Table 5 – Reference constructions

Nominal cross-sectional area	Number of wires	Individual wire diameter	Catenary wire diameter	Calculated resistance	Unit mass	Calculated cross-sectional area	Stranding factor	Calculated breaking load							
								C0	C1	C2	C3	C4	C5	C6	C7
		mm ±1 %	mm ±1 %	Ω/km	kg/km ±3 %	mm² ±2 %		kN	kN	kN	kN	kN	kN	kN	kN
35	7	2,5	7,5	0,508 3	309,4	34,4	1,012 96	13,33	13,33	15,20	16,13	19,23	19,69		23,99
50	7	3,0	9,0	0,353 0	445,6	49,5	1,012 96	19,20	19,20	21,88	23,22	27,69			
65	7	3,5	10,5	0,259 3	606,5	67,3	1,012 96	25,77	25,77	29,48	30,39	36,47			
90	7	4,0	12,0	0,198 5	792,1	88,0	1,012 96	33,18	33,18	38,03	39,69	47,63			
35	19	1,5	7,5	0,522 8	303,9	33,6	1,018 11	13,03	13,03	14,85	15,76	18,79		22,21	
60	19	2,0	10,0	0,294 1	540,3	59,7	1,018 11	23,16	23,16	26,40	28,01	33,40	36,30	38,34	43,12
95	19	2,5	12,5	0,188 2	844,2	93,3	1,018 11	36,19	36,19	41,24	43,77	52,19	53,46		65,12
135	19	3,0	15,0	0,130 7	1 215,6	134,3	1,018 11	52,12	52,12	59,39	63,03	75,15			
185	19	3,5	17,5	0,096 0	1 654,5	182,8	1,018 11	69,95	69,95	80,01	82,49	98,99			
240	19	4,0	20,0	0,073 5	2 161,0	238,8	1,018 11	90,07	90,07	103,22	107,74	129,29			
30	37	1,0	7,0	0,605 6	263,7	29,1	1,020 68	11,28	11,28	12,85	13,64	16,26			
65	37	1,5	10,5	0,269 1	593,3	65,4	1,020 68	25,37	25,37	28,91	30,68	36,59		43,26	
115	37	2,0	14,0	0,151 4	1 054,7	116,2	1,020 68	45,11	45,11	51,40	54,55	65,04	70,70	74,66	83,98
180	37	2,5	17,5	0,096 9	1 648,0	181,6	1,020 68	70,48	70,48	80,32	85,24	101,63	104,10		126,82
260	37	3,0	21,0	0,067 3	2 373,2	261,5	1,020 68	101,50	101,50	115,66	122,74	146,34			
355	37	3,5	24,5	0,049 4	3 230,1	356,0	1,020 68	136,22	136,22	155,82	160,64	192,76			
50	61	1,0	9,0	0,367 8	435,3	47,9	1,022 10	18,59	18,59	21,19	22,48	26,81			
110	61	1,5	13,5	0,163 5	979,5	107,8	1,022 10	41,83	41,83	47,67	50,59	60,32		71,32	
190	61	2,0	18,0	0,092 0	1 741,3	191,6	1,022 10	74,37	74,37	84,75	89,94	107,23	116,55	123,09	138,45
300	61	2,5	22,5	0,058 9	2 720,8	299,4	1,022 10	116,20	116,20	132,42	140,52	167,55	171,63		209,08

NOTE All values are calculated based on a conductivity of 100 % IACS or resistivity of 17,241 nΩm, the reference lay ratios of Table 6 and a density of 8,89 g/cm³.

The deviations on unit mass and resistance resulting from extreme length of lay values result in a deviation less than 0,9 % from the tabled values, and these deviations can be considered as part of the tolerance. The combined tolerance has been rounded up to 3 % for convenience for unit mass.

The calculated breaking load is in accordance with Annex C. The values for unit mass are calculated in accordance with Annex D.

Definition of unit mass and electrical resistance for various types of catenary wires with different lay ratios is given in Annex D.