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EN 50306-1

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English Version

Railway applications - Railway rolling stock cables having special fire performance - Thin wall - Part 1: General requirements

Applications ferroviaires - Câbles pour matériel roulant ferroviaire ayant des performances particulières de comportement au feu - Isolation mince - Partie 1: Exigences générales

Bahnanwendungen - Kabel und Leitungen für Schienenfahrzeuge mit verbessertem Verhalten im Brandfall - Reduzierte Isolierwanddicken - Teil 1: Allgemeine Anforderungen

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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European foreword

This document (EN 50306-1:2020) has been prepared by CLC/TC 20, “Electric cables”.

The following dates are fixed:

• latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2020-12-30
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2022-12-30

This document supersedes EN 50306-1:2002 and all of its amendments and corrigenda (if any).

This edition includes the following significant technical changes with respect to the previous edition:

— the documents have been updated to reflect the changes in the test standard EN 50305;

— the range of the conductor cross sections has been extended;

— the reference to cited standards (e.g. 60811 series) has been updated.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Introduction

The railway industry is generally concerned with the movement of people as well as goods. It is therefore essential that a high level of safety is achieved, even when failures occur which could involve fire, howsoever caused, affecting railway rolling stock.

Hence it is necessary to provide cables for use in railway environments which minimize the hazard to people when a fire could damage the cable, irrespective of whether the fire is caused by an external source or from within the electrical system.

The EN 50306 series specifies cables which, in the event of fire will limit the risk to people and improve the safety on railways in general. It covers cables with thin wall thickness of both insulation and sheath, based on halogen free materials, for use in railway rolling stock. There is provision for screening in some of the parts and also for a standard wall thickness sheath. In the event of a fire affecting cables to the EN 50306 series they will have a limited flame spread and limited emission of toxic gases. In addition these cables when burnt, produce limited amounts of smoke. This last characteristic will minimize loss of visibility in the event of a fire and will aid reduced evacuation times.

The objectives of this standard are:

— to standardize cables that are safe and reliable when properly used;

— to state the characteristics, performance, and construction requirements directly or indirectly bearing on safety;

— to specify methods for checking conformity with these requirements.

The EN 50306 series, which covers a range of cables of rated voltage U_0 = 300V with conductor sizes 0,5 mm^2 up to 2,5 mm^2, is divided into 4 parts:

Part 1: General requirements;

Part 2: Single core cables;

Part 3: Single core and multicore cables screened and thin wall sheathed;

Part 4: Multicore and multipair screened or not screened sheathed cables.

These cables are intended for a limited number of applications. Further information on these applications is given in EN 50355 and EN 50343.

Special test methods referred to in the EN 50306 series are given in EN 50305.

A separate European Standard, the EN 50264 series covers cables for similar applications up to 3,6/6 kV rating with a conductor temperature at 90°C, but with standard wall and medium wall thicknesses of both insulation and sheath, and provides for a maximum conductor size of 400 mm^2.

A separate European Standard, the EN 50382 series covers cables for similar applications up to 3,6/6 kV rating with a conductor temperature at 120°C and 150°C, and provides for a maximum conductor size of 400 mm^2.

1 Scope

EN 50306-1 specifies the general requirements applicable to the cables given in EN 50306-2, EN 50306-3 and EN 50306-4. It includes the detailed requirements for S2 sheathing materials and other components called up in the separate parts.

NOTE Detailed requirements for insulation systems are given in EN 50306-2.

In particular, EN 50306-1 specifies those requirements relating to fire safety which enable the cables to satisfy Hazard Level 3 of EN 45545-1 and EN 45545-2.

These cables are rated for occasional thermal stresses which causes ageing equivalent to continuous operational life at a temperature of 105 °C or 90 °C. For standard cables, this is determined by the acceptance test defined in EN 50305, using accelerated long-term (5 000 h) thermal ageing indicating a 125 °C or 110 °C /20 000 h temperature index. If the customer were to require lifetime predictions, this would be demonstrated based on the temperature index of the product as supplied by the manufacturer. The maximum temperature for short circuit conditions is 160 °C based on duration of 5 s.

EN 50306-1 is expected to be used in conjunction with one or more of the other parts of EN 50306.

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.

EN 50264-1, *Railway applications — Railway rolling stock power and control cables having special fire performance — Part 1: General requirements*

EN 50305:2020, *Railway applications — Railway rolling stock cables having special fire performance - Test methods*

EN 50306-2:2020, *Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 2: Single core cables*

EN 50306-3:2020, *Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 3: Single core and multicore cables screened and thin wall sheathed*

EN 50306-4:2020, *Railway applications — Railway rolling stock cables having special fire performance — Thin wall — Part 4: Multicore and multipair screened or not screened sheathed cables*

EN 50355, *Railway applications — Railway rolling stock cables having special fire performance — Guide to use*

EN 60332-1-2, *Tests on electric and optical fibre cables under fire conditions — Part 1-2: Test for vertical flame propagation for a single insulated wire or cable — Procedure for 1 kW pre-mixed flame*

EN IEC 60332-3-24:2018, *Tests on electric and optical fibre cables under fire conditions — Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables — Category C*

EN 60332-3-25, *Tests on electric and optical fibre cables under fire conditions — Part 3-25: Test for vertical flame spread of vertically-mounted bunched wires or cables — Category D*

EN 60754-1, *Test on gases evolved during combustion of materials from cables — Part 1: Determination of the halogen acid gas content*

EN 60754-2, *Test on gases evolved during combustion of materials from cables — Part 2: Determination of acidity (by pH measurement) and conductivity*

EN 61034-2, *Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements*

EN 60684-2, *Flexible insulating sleeving — Part 2: Methods of test*

EN 60811 (all parts), *Electric and optical fibre cables — Test methods for non-metallic materials*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 50306 (series) and the following 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
insulation system
insulation
— polymers, copolymers or alloys which contain aromatic groups and heteroelements such as N, O or Si in the main chain of the polymer molecules;

— polymers, copolymers or alloys of olefinic type, crosslinked if necessary

3.2
sheathing system
sheath
— type S2 sheath materials are compounds which contain aromatic groups and hetero-elements such as N, O or Si in the main chain of the polymer molecules, or polymers or copolymers in which the characteristic constituent is a copolymer of ethylene, cross-linked if necessary;

— type EM 101, EM 102, EM 103 and EM 104 sheath materials as given in EN 50264-1 for standard wall sheathed cables

3.3
halogen-free material
combustible material which, when tested in accordance with the designated method, conforms to the requirements given in EN 50305:2020, Annexes F and G

3.4
type tests
T
tests required to be performed before supplying a type of cable covered by this document on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

Note 1 to entry: These tests are of such a nature that, after they have been made, they need not be repeated unless changes are made in the cable materials, design or type of manufacturing process which might change the performance characteristics.

3.5
sample tests
S
tests performed on samples of completed cable, or components taken from a completed cable adequate to verify that the finished product meets the design specification

3.6
routine tests
R
tests performed on all complete cable lengths to demonstrate their integrity

4 Rated voltage

The rated voltage of a cable is the reference voltage for which the cable is designed, and which serves to define the electrical tests.

The rated voltage is expressed by the combination of the following values (in volts):

$U_0/U(U_m)$

where

U_0 is the r.m.s. value between any insulated conductor and earth, i.e. metal covering of the cable or the surrounding medium, e.g. U_0 = 300 V;

U is the r.m.s. value between any two phase-conductors of a multicore cable or of a system of single-core cables, e.g. U = 300 V;

U_m is the maximum r.m.s. value of the “highest system voltage” for which the equipment may be used, e.g. U_m = 320 V.

In an alternating current system, the rated voltage of a cable shall be at least equal to the nominal voltage of the system for which it is intended.

In a direct current system, the cables shall have a maximum voltage against earth (Vo) not exceeding 1,5 times the rated voltage (U_0) of the cable, where:

V_0 is the DC value between any insulated conductor and earth, i.e. metal covering of the cable or the surrounding medium, e.g. V_0 = 410 V.

The rated voltage recognized for the purposes of all parts of EN 50355 shall be as given in Table 1.

NOTE In the Railway Industry it is common practice to identify cables and systems by the value of U_0, not the more usual normal practice of U.

Table 1 — Voltages

Rated Voltage [U_0/U]	max. permissible operating voltage			
	AC		DC	
	Conductor to earth	Conductor to conductor [U_m]	Conductor to earth [V_o]	Conductor to conductor
300/300 V	320 V	320 V	410 V	410 V
300/500 V	320 V	550 V	410 V	820 V

5. Marking

5.1 Indication of origin

Cables shall be provided with an indication of origin consisting of the continuous marking of the manufacturer's name, trademark, or registered identification number by one of the following methods:

1) printing on the insulation of at least one core;

2) printing, indenting or embossing on the outer surface of sheathed cable.

5.2 Continuity of marks

Each specified mark shall be regarded as continuous if the distance between the end of the mark and the beginning of the next identical mark does not exceed

– 550 mm if the marking is on the outer surface of the cable,

– 275 mm if the marking is on the insulation of a sheathed cable.

NOTE 1 A “specified mark” is any mandatory mark covered by this Part 1 of EN 50306 or by the particular requirements of Part 2, 3 or 4.

NOTE 2 An example of marking on the outer surface of the cable is given in Figure 1.

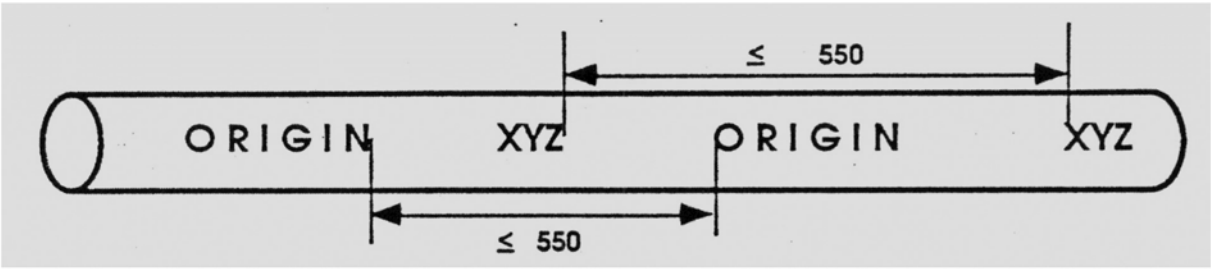

Figure 1 — Example of marking

Conformity shall be checked by visual examination and measurement.

5.3 Durability

Printed markings shall be durable. Conformity is checked by the test given in EN 50305:2020, 10.1.

5.4 Legibility

All markings shall be legible. Printed markings shall be in contrasting colours.

5.5 Additional marking

Additional marking, specific to the individual cable type, shall be given in the particular specification. Additional marking may be added to allow better identification.

5.6 Use of the name CENELEC

The name CENELEC, in full or abbreviated, shall not be directly marked on, or in, the cables.

6 General requirements for the construction of cables

6.1 Conductors

6.1.1 Material

The conductors shall be tin coated annealed copper.

6.1.2 Construction

Conductors shall be stranded in such a manner as to achieve a smooth uniform substantially circular outer surface.

The conductor diameter shall be within the limits specified in EN 50306-2:2020, Table 1.

6.1.3 Check of construction

Conformity with the requirements of 6.1.1 and 6.1.2 is checked by inspection and by measurement.

6.1.4 Electrical resistance

The resistance of each conductor at 20 °C shall be in accordance with the requirements of the relevant table in EN 50306-2.

Conformity is checked by the test given in EN 50305:2020, 6.1.

6.2 Insulation system

6.2.1 Material

The insulation system shall be manufactured from material as defined in 3.1 of this part and shall conform to the requirements given in EN 50306-2.

6.2.2 Application

The insulation system shall be applied by extrusion and may consist of one or more closely adherent layers. The insulation system shall form a compact and homogeneous body and shall be so applied that it fits closely on the conductor and it shall be possible to remove the insulation without damage to itself, or to the tinned conductor.

The insulation system shall be smooth, uniformly applied and be substantially circular.

Conformity is checked by inspection and by manual testing.

6.2.3 Thickness and concentricity

The value of the thickness of the insulation shall not be, at any place, less than the specified value for each type and size of cable shown in EN 50306-2:2020, Table 1. Conformity shall be checked by the procedure given in A.1.

The insulation concentricity, as determined by the procedure in A.1.3, shall not be less than 0,7.

6.3 Fillers and tapes

6.3.1 Material

Fillers and tapes, if any, shall be composed of non-hygroscopic and halogen-free material, have no harmful interactions with the constituents of the cable, be suitable for the operating temperature and be compatible with the cable components with which they are in contact.

Conformity with this requirement is checked by the tests given in the particular specification.

6.3.2 Application

Where fillers are used, these shall be applied to form a compact and reasonably circular cable. It shall be possible to remove the filler, if any, from the cable without damaging the insulation of cores.

NOTE Tapes can be applied as a separator over the insulation of an individual core or as a binder over the core assembly.

6.4 Inner sheath

6.4.1 Material

The inner sheath shall be a system meeting all the requirements of Table 3 and the particular specification for the applicable type of cable.

The test requirements and the reference to test methods are given in the particular specification.

NOTE EN 50306-2 and EN 50306-3 do not contain constructions requiring an inner sheath.

6.4.2 Application

The inner sheath shall not adhere to the cores.

6.4.3 Thickness

The thickness of the inner sheath shall be as detailed in the particular specification. Conformity is checked by the test given in A.2.

6.5 Metallic screen

6.5.1 Type of screen

Where a metallic screen is specified it shall conform to the detailed construction given in the particular specification.

Conformity with these requirements is checked by inspection and measurement.

6.5.2 Application

Requirements for application shall be given in the particular specification.

6.6 Sheath

6.6.1 Material

The sheath shall be manufactured from a system as defined in 3.2 so designated for each type as follows:

— type S2 for thin wall sheathed cables in EN 50306-3:2020;

— types EM 101 to EM 104, for sheathed cables in EN 50306-4:2020.

The requirements for type S2 are specified in Table 3, and those for EM 101 to EM 104 are specified in EN 50264-1.

6.6.2 Application

The sheath shall be extruded and consist of one or more layers.

The sheath shall be smooth and uniformly applied.

Where necessary a separator, consisting of a tape, may be placed beneath the sheath.

6.6.3 Thickness

The thickness of the sheath shall be as detailed in the particular specification for each type and size of cable shown in the relevant tables.

The value of the thickness of the sheath of cable according to EN 50306-3:2020 or EN 50306-4:2020 Class P shall not, at any point, be less than the specified value.

The value of the thickness of the sheath of cable according to EN 50306-4:2020 Class E shall not, by average, be less than the specified value. The minimum value of the thickness at any point may be lower to the specified value, if the difference is not higher than 0,1 mm + 15 % of the specified value.

Conformity is checked by the test given in A.2.

6.7 Overall diameter

The overall diameter of the cable shall be as detailed in the particular specification for each type and size of cable shown in the relevant table.

The overall diameter shall be within the limits given for the particular cable.

Conformity is checked by the test given in A.3.

7 Electrical performance

The electrical performance of the completed cable shall be as given in the relevant parts of EN 50306.

8 Fire performance - cables

8.1 Flame propagation (flame spread) - single vertical cable

The completed cable shall be tested in accordance with EN 60332-1-2, and shall conform to the recommended performance requirements given in Annex A of that standard.

8.2 Flame propagation (flame spread) - bunched cables

8.2.1 Cables with diameter more than or equal to 12 mm

The completed cable shall be tested in accordance with EN 60332-3-24, and shall conform to the recommended performance requirements given in EN IEC 60332-3-24:2018, Annex B.

8.2.2 Cables with diameter greater than 6 mm and less than 12 mm

The completed cable shall be tested in accordance with EN 60332-3-25.

At the conclusion of the test the maximum extent of the charred portion measured on the sample shall not have reached a height exceeding 2,5 m above the bottom edge of the burner, neither at the front nor the rear of the ladder.

8.2.3 Cables with diameter not greater than 6 mm

The completed cable shall be tested in accordance with EN 50305:2020, 9.1.2.

At the conclusion of the test the maximum extent of the charred portion measured on the sample shall not have reached a height exceeding 1,5 m above the bottom edge of the burner, neither at the front nor the rear of the ladder.

8.3 Smoke emission

The completed cable shall be tested in accordance with EN 61034-2.

The percentage light transmittance, measured in accordance with the procedures specified in EN 61034-2 shall be not less than 70 %.

NOTE The minimum value of 70 % is the requirement R15 of Hazard Level 3 as given in EN 45545-2.

9 Fire performance - components

9.1 Tests for corrosive and acid gas emission, and for fluorine

Samples of insulation, inner sheath, sheath and, where applicable fillers and tapes, shall be tested in accordance with EN 60754-1, EN 60754-2 and EN 60684-2.

The maximum evolution of HCl, minimum pH, maximum conductivity and maximum fluorine content shall be in accordance with the requirements given inEN 50305:2020, Annex F.

9.2 Toxicity

The component parts of the cable shall be tested in accordance with EN 50305:2020, 9.2.

The toxicity index shall not exceed values of Table 2.

Table 2 — Maximum Toxicity index

Hazard level	max. Toxicity index (ITC)	
	Insulation	EM101 to 104 and S2 sheath
3	6	3

If the toxicity index of any of the non extruded elements is higher than 6 and the combined mass of these elements (fillers, tapes and binders) does not exceed 5 % of the total weight of combustible materials in the cable, then the whole cable shall not exceed the weighted toxicity (ITC´) of 3.

The weighted toxicity index is defined as:

$$ITC' = \frac{\Sigma_i (ITC_i \times m_i)}{\Sigma_i m_i}$$

ITCi: is the ITC of each non-metallic

m_i: is the mass per metre of each non-metallic material

i: all extruded and non- extruded non-metallic materials

ITC´: weighted toxicity of the whole cable per meter

Table 3 — Requirements for non-electrical tests for Halogen-free sheathing materials

1	2	3	4	5	6
Ref No.	Test	Unit	Test method given in		
			EN	(Sub) clause	S2
1	Mechanical properties				
1.1	Properties in the state as delivered		60811–501		
1.9	Elongation at break:				
	Minimum value to be obtained	%			100

Annex A
(normative)

Thickness and overall diameter
Selection of samples and calculation of results

A.1 Insulation thickness

A.1.1 Procedure

The thickness of insulation shall be measured in accordance with EN 60811-201. Three samples shall be taken from the cable; each sample shall be separated from the next by a distance of at least 1 m.

Compliance shall be checked on each core of cable.

If withdrawal of the conductor is difficult, it shall be stretched in a tensile machine or the piece of core shall be loosened by stretching or some other suitable means that does not damage the insulation.

A.1.2 Evaluation of results

The mean of the 18 values (expressed in millimetres) obtained from the three pieces of insulation for each core shall be calculated to two decimal places and rounded off as given below, and this shall be taken as the mean value of the thickness of insulation.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number, thus for example, 1,74 shall be rounded to 1,7 and 1,75 to 1,8.

The lowest of all values obtained shall be taken as the minimum thickness of insulation at any place.

A.1.3 Concentricity

The concentricity shall be the ratio of the smallest measured thickness to the largest measured thickness, as determined from the measurements in A.1.1 and A.1.2.

A.2 Measurement of sheath thickness

A.2.1 Procedure

The thickness of the sheath shall be measured in accordance with EN 60811-202.

One sample of cable shall be taken from each of three places, separated by at least 1 m.

A.2.2 Evaluation of results

The mean of all the values (expressed in millimetres) obtained from the three pieces of sheath shall be calculated to two decimal places and rounded off as given below, and this shall be taken as the mean value of the thickness of sheath.

If in the calculation the second decimal figure is 5 or more, the first decimal figure shall be raised to the next number; thus for example, 1,74 shall be rounded to 1,7 and 1,75 to 1,8.

The lowest of all values obtained shall be taken as the minimum thickness of sheath at any place.

A.3 Measurement of overall diameter

The three samples taken in accordance with A.1 or A.2 shall be used.

The measurement of the overall diameter of any circular cable shall be carried out in accordance with EN 60811-203.

The mean of the values obtained shall be taken as the mean overall diameter.

Bibliography

EN 45545-1, *Railway applications — Fire protection on railway vehicles — Part 1: General*

EN 45545-2, *Railway applications — Fire protection on railway vehicles — Part 2: Requirements for fire behaviour of materials and components*

EN 50343, *Railway applications — Rolling stock — Rules for installation of cabling*