BRITISH STANDARD

BS EN 50382-1:2008 +A1:2013

Railway applications — Railway rolling stock high temperature power cables having special fire performance —

Part 1: General requirements

ICS 13.220.40; 29.060.20; 45.060.01

BSI British Standards

National foreword

This British Standard is the UK implementation of EN 50382-1:2008+A1:2013. It supersedes BS EN 50382-1:2008, which will be withdrawn on 29 April 2016.

The UK participation in its preparation was entrusted to Technical Committee GEL/20, Electric cables.

A list of organizations represented on this committee can be obtained on request to its secretary.

The publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

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Railway applications - Railway rolling stock high temperature power cables having special fire performance - Part 1: General requirements

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

Bahnanwendungen - Hochtemperaturkabel und -leitungen für Schienenfahrzeuge mit verbessertem Verhalten im Brandfall - Teil 1: Allgemeine Anforderungen

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared for the Technical Committee CENELEC TC 20, Electric cables, by Working Group 12, Railway Cables, as part of the overall programme of work in the Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50382-1 on 2008-02-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-02-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-02-01

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Foreword to amendment A1

This document (EN 50382-1:2008/A1:2013) 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)	2014-04-29
• latest date by which the national standards conflicting with this document have to be withdrawn	(dow)	2016-04-29

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

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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 may involve fire, howsoever caused, affecting railway rolling stock.

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

EN 50382 specifies cables for power and associated circuits which, in the event of fire, will limit the risk to people and improve the safety on railways in general. It covers cables, for use in railway rolling stock, and having standard wall thickness of insulation, based on materials that allow them to operate at high temperature and which are also halogen free. In the event of a fire affecting cables to EN 50382 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 minimise loss of visibility in the event of a fire and will aid reduced evacuation times.

The objects of this standard are

– to standardise 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.

EN 50382, which covers a range of cables rated at up to 3,6/6 kV with conductor sizes 1,5 mm² up to 400 mm², is divided into 2 parts:

– Part 1: General requirements;

– Part 2: Single core silicone rubber insulated cables for 120 °C or 150 °C.

These cables are intended for a limited number of applications.

Information regarding selection and installation of cables including current ratings can be found in EN 50355 and EN 50343. The procedure for selection of cable cross-sectional area, including reduction factors for ambient temperature and installation type, are described in EN 50343.

NOTE Current ratings for inclusion in EN 50355 are under development for the next amendment.

Special test methods referred to in EN 50382 are given in EN 50305.

1 Scope

This Part 1 of EN 50382 specifies the general requirements applicable to the cables given in EN 50382-2. It includes the detailed requirements for the insulating and sheathing materials and other components called up in EN 50382-2. In particular EN 50382-1 specifies those requirements relating to fire safety.

Based on proven experience and reliability over many years these cables are rated for occasional thermal stresses causing ageing equivalent to continuous operational life at a conductor temperature of either 120 °C or 150 °C.

NOTE This rating is based upon the polymer defined in 3.1. Before this polymer had gained widespread acceptance in the cable industry, ageing performance had been assessed via long term thermal endurance testing and had been extrapolated to 20 000 h using techniques equivalent to those in EN 60216. Subsequent experience in service has demonstrated that the predicted performance levels were correct.

Where extrapolated data is used to predict lifetime in service it should be confirmed with the cable manufacturer, and should be based on a failure mode appropriate to the type of material or cable.

The maximum temperature for short circuit conditions for silicone rubber is 350 °C based on a duration of 5 s.

Although both of the insulating and one of the sheathing compounds specified in this standard are thermally capable of operating at 150 °C, where tinned conductors are used the maximum operating temperature is limited to 120 °C and for the same technical reason the maximum short circuit temperature, for tinned copper conductors, is limited to 250 °C. The choice of sheath may also limit the operating temperature to 120 °C.

The temperature limit for maximum operating of 120 °C for tinned conductors may be increased to 150 °C by agreement between the purchaser and the manufacturer.

This Part 1 should be used in conjunction with EN 50382-2.

2 Normative references

The following referenced documents are indispensable for the application 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 10002-1	Metallic materials – Tensile testing – Part 1: Method of test (at ambient temperature)
EN 50266-2-4	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables – Part 2-4: Procedures – Category C
EN 50266-2-5	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables – Part 2-5: Procedures – Small cables – Category D
EN 50267-2-1	Common test methods for cables under fire conditions – Tests on gases evolved during combustion of materials from cables – Part 2–1: Procedures – Determination of the amount of halogen acid gas
EN 50267-2-2	Common test methods for cables under fire conditions – Tests on gases evolved during combustion of materials from cables – Part 2–2: Procedures – Determination of degree of acidity of gases for materials by measuring pH and conductivity
EN 50305:2002	Railway applications – Railway rolling stock cables having special fire performance – Test methods

EN 50382-2	Railway applications – Railway rolling stock high temperature power cables having special fire performance – Part 2: Single core silicone rubber insulated cables for 120 °C or 150 °C
EN 60228	Conductors of insulated cables (IEC 60228)
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 (IEC 60332-1-2)
EN 60684-2	Flexible insulating sleeving – Part 2: Methods of test (IEC 60684-2)
EN 60811-1-1:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-1: General application – Measurement of thickness and overall dimensions – Tests for determining the mechanical properties (IEC 60811-1-1:1993)
EN 60811-1-2:1995	Insulating and sheathing materials of electric cables – Common test methods – Part 1–2: General application – Thermal ageing methods (IEC 60811-1-2:1985 + A1:1989 + corr. May 1986)
EN 60811-1-3:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1-3: General application – Methods for determining the density – Water absorption tests – Shrinkage test (IEC 60811-1-3:1993)
EN 60811-1-4:1995	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 1–4: General application – Tests at low temperature (IEC 60811-1-4:1985 + A1:1993 + corr. May 1986)
EN 60811-2-1:1998	Insulating and sheathing materials of electric and optical cables – Common test methods – Part 2–1: Methods specific to elastomeric compounds – Ozone resistance, hot set and mineral oil immersion tests (IEC 60811-2-1:1998)
EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Procedure and requirements (IEC 61034-2)

3 Definitions

For the purposes of all parts of EN 50382, the following terms and definitions apply. The types or combination of insulating and sheathing compounds covered in this EN are listed below.

3.1
cross-linked silicone rubber (SiR)
compound based on a poly-siloxane polymer which, when cross-linked, meets with the requirements given in the particular specification

3.2
cross-linked ethylene copolymers
compound in which the characteristic constituent is a copolymer of ethylene such as EVA or other, which, when cross-linked, complies with the requirements given in the particular specifications

3.3
type of compound
category, designated by one or several characteristics, in which a compound is placed according to its properties, as determined by specific tests

NOTE The type designation is not directly related to the composition of the compound. See also 6.2.1 and 6.4.1.

3.4
halogen-free material
combustible material which complies with the requirements of Annexes A and B

3.5
variation
difference between the median value after treatment and the median value without treatment, expressed as a percentage of the latter

3.6
type tests (symbol T)
tests required to be made before supplying a type of cable covered by this standard on a general commercial basis in order to demonstrate satisfactory performance characteristics to meet the intended application

NOTE 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.

3.7
sample tests (symbol S)
tests made on samples of completed cable, or components taken from a completed cable adequate to verify that the finished product meets the design specification

3.8
routine tests (symbol R)
tests made 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 *V* is expressed by the combination of the following values (in volts):

U_o/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 = 1 800 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 = 3 000 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 = 3 600 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 (V_0) not exceeding 1,5 times the rated voltage (U_0) of the cable, where

V_0 is the d.c. value between any insulated conductor and earth, i.e. metal covering of the cable or the surrounding medium, e.g. V_0 = 2 700 V.

The rated voltage recognized for the purposes of all parts of EN 50382 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_o, not the more usual practice of U.

Table 1 – Rated voltages

Rated voltage *V*			
U_o	U	U_m	V_o
1 800	3 000	3 600	2 700
3 600	6 000	7 200	5 400
NOTE See Guide to use (EN 50355) for further information.			

5 Marking

5.1 Indication of origin

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

1) a printed tape within the cable;

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

3) printing on the outer surface of the cable.

NOTE Additional markings may be specified in EN 50382-2.

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

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

b) 275 mm if the marking is on the insulation or on a tape.

NOTE 1 A "specified mark" is any mandatory mark covered by this Part of EN 50382 or by the particular requirements of Part 2.

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

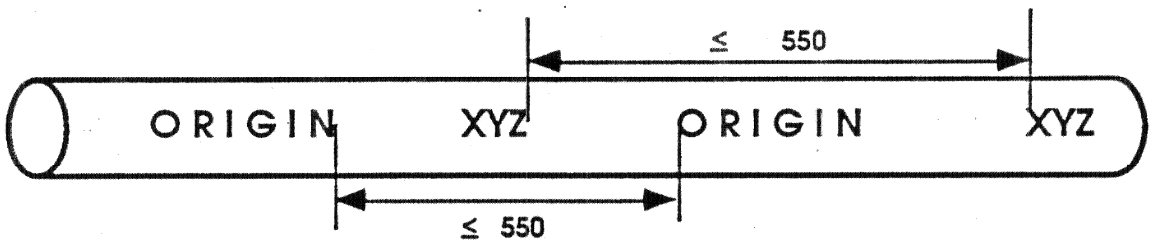

Figure 1 – Example of marking

Compliance shall be checked by visual examination and measurement.

5.3 Durability

Printed markings shall be durable.

Compliance shall be checked by the test given in EN 50305, 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 EN 50382-2.

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 or plain annealed copper.

When tested in accordance with EN 10002-1 the minimum average elongation of wires from the conductors shall be 15 %, with a minimum value of 10 % for an individual wire.

6.1.2 Construction

Conductors shall be in accordance with EN 60228.

NOTE The classes of the conductors relevant to the various types of cables are given in EN 50382-2.

6.1.3 Check of construction

Conformity with the requirements of 6.1.1 and 6.1.2 shall be 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 EN 60228 for the given class of conductor.

Compliance shall be checked by the test given in EN 50305, 6.1.

6.1.5 Separator tape

It is permitted to place a non-hygroscopic separator tape of coloured material between the conductor and insulation. If used, the separator tape shall be easily removable from the conductor.

6.1.6 Conductor screening

Where specified in EN 50382-2 the conductor screening shall consist of a semiconducting tape, a layer of extruded semi-conducting compound, or a combination of both.

It shall be easily removable from the conductor.

6.2 Insulation system

6.2.1 Material

The insulation system shall be manufactured from materials as defined in 3.1 of this part. It shall conform to the requirements given in Table 2 and as specified for each type of cable in EN 50382-2.

Insulation types available are

a) for unsheathed cables:

– Type EI 111: extra low temperature resistant, oil resistant;

b) for sheathed cables:

– Type EI 111: extra low temperature resistant, oil resistant;

– Type EI 112: extra low temperature resistant.

NOTE Compound Type EI 112 is not oil resistant.

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, the separator tape or conductor screening and it shall be possible to remove the insulation without to damage the conductor.

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

Conformity shall be checked by inspection and by manual testing.

6.2.3 Thickness

The mean value of the thickness of insulation shall not be less than the specified value for each type and size of cable as specified in EN 50382–2.

It is permissible for the thickness at any one place to be less than the specified value provided that the difference does not exceed 0,1 mm + 10 % of the specified value.

Conformity shall be checked by the procedure given in Annex C.

6.3 Tapes

6.3.1 General

It is permitted to apply tapes as a separator over the insulation.

In such cases the requirements in 6.3.2 shall apply.

6.3.2 Material

Tapes, if any, shall be composed of non-hygroscopic and halogen free material, having 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 shall be checked by the tests given in EN 50382-2.

Tapes, if any, shall be halogen free.

Conformity shall be checked by the tests specified in 9.1.

6.4 Sheath

6.4.1 Material

The sheath shall be a material as defined in 3.1 or 3.2. It shall conform to the requirements given in Table 3 and as specified for each type of cable in EN 50382-2.

Sheath types available are

a) for cable rated at 120 °C:

- Type EM 105: low temperature resistant, oil resistant;

- Type EM 106: extra low temperature resistant, oil resistant;

b) for cable rated at 150 °C:

- Type EM 107: extra low temperature resistant, oil resistant.

6.4.2 Application

The sheath shall be applied by extrusion in one or more closely adherent layers of the same type.

The sheath shall form a compact, homogeneous body and shall be so applied that it fits closely over the core or separator tape. It shall be smooth on the outer surface, uniform without blisters, lumps or other defects and shall not adhere to the core.

It shall be possible to remove the sheath without damage to the insulation.

NOTE A separator, consisting of a tape, may be placed beneath the sheath.

Conformity shall be checked by inspection and by manual testing.

6.4.3 Thickness

The mean value of the thickness of the sheath shall not be less than the specified value for each type and size of cable as given in EN 50382-2.

It is permissible for the thickness at any one place to be less than the specified value provided that the difference does not exceed 0,1 mm + 15 % of the specified value.

Conformity shall be checked by the test given in Annex C.

6.5 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 shall be checked by the test given in Annex C.

6.6 Non-metallic components

All non-metallic components shall be halogen free.

Conformity shall be checked by the tests specified in 9.1 and 9.2.

7 Electrical performance

The electrical performance of the completed cable shall be as given in EN 50382-2.

8 Reaction to fire – 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 50266-2-4, and shall conform to the recommended performance requirements given in Annex B of that standard.

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 50266-2-5.

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.

8.3 Smoke emission

The completed cable shall be tested in accordance with EN 61034-2. The percentage light transmission shall not be less than 70 %

9 Reaction to fire – Components

9.1 Assessment of halogens

Samples of insulation, sheath and, where applicable, fillers and tapes shall be tested in accordance with Annex A.

The maximum evolution of HCl, minimum pH, maximum conductivity and maximum fluorine content shall be in accordance with the requirements given in Annex A as applicable.

9.2 Toxicity

All cable materials shall be tested in accordance with EN 50305, 9.2. The toxicity index shall not exceed 3.

If the toxicity index of any of the non extruded elements is higher than 3 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:

$$ITC' = \frac{\sum_i ITC_i \times w_i}{\sum_i w_i}$$

where

ITC_i :	ITC of each extruded or non extruded non metallic material
w_i :	weight of the extruded or non extruded non metallic material per meter
i:	all extruded and non- extruded non-metallic materials
ITC´ :	weighted toxicity of the whole cable per meter

Table 2 – Requirements for the tests for halogen free insulating compounds for Part 2

1	2	3	4	5	6	7
Ref No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EI 111	**EI 112**	**EN**	**Clause**
	Operating temperature [a]	°C	150	150		
1	**Mechanical properties**					
1.1	Properties in the state as delivered				60811-1-1	9.1
1.1.1	Values to be obtained for tensile strength:					
	- median. min.	MPa	8,0	5,0		
1.1.2	Values to be obtained for the elongation at break:					
	- median min.	%	200	150		
1.2	Properties after ageing in air oven				60811-1-2	8.1
1.2.1	Ageing conditions:					
	- temperature	°C	200 ± 3	200 ± 3		
	- duration of treatment	h	240	240		
1.2.2	Values to be obtained for the tensile strength:					
	- median. min.	MPa	6,0	4,0		
1.2.3	Values to be obtained for the elongation at break:					
	- median. min.	%	160	120		
2	**Hot set test**				60811-2-1	9
2.1	Conditions of treatment:					
	- temperature	°C	250 ± 3	250 ± 3		
	- time under load	min	15	15		
	- mechanical stress	N/cm²	20	20		
2.2	Test requirements:					
	- max. elongation under load	%	100	100		
	- max. elongation after unloading	%	25	25		

Table 2 – Requirements for the tests for halogen free insulating compounds for Part 2 *(continued)*

1	2	3	4	5	6	7
Ref No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EI 111	**EI 112**	**EN**	**Clause**
3	**Ozone resistance**				50305	7.4.2
3.1	Concentration Method A	%	(250-300) x 10^{-4}	(250-300) x 10^{-4}		
	Method B (alternative)	%	(200 ± 50) x 10^{-6}	(200 ± 50) x 10^{-6}		
3.2	Test temperature Method A	°C	25 ± 2	25 ± 2		
	Method B	°C	40 ± 2	40 ± 2		
3.3	Test duration Method A	h	24	24		
	Method B	h	72	72		
3.4	Results to be obtained		No cracks	No cracks		
4	**Mineral oil resistance**			N.A.	60811-2-1	10
4.1	Treatment type of oil: IRM902 - temperature: - duration:	 °C h	 100 ± 2 24			
4.2	Tensile strength: - variation max.	%	± 25			
4.3	Elongation at break: - variation max.	%	± 30			
5	**Bending test at low temperature** [b]				60811-1-4	8.1
5.1	Treatment: - temperature	°C	-40	-40		
5.2	Result to be obtained		No cracks	No cracks		
6	**Elongation test at low temperature** [c]				60811-1-4	8.3
6.1	Treatment: - temperature	°C	-40	-40		
6.2	- elongation min.	%	30	30		

Table 2 – Requirements for the tests for halogen free insulating compounds for Part 2 *(continued)*

1	2	3	4	5	6	7
Ref No.	**Test**	**Unit**	**Type of compound**		**Test method described in**	
			EI 111	**EI 112**	**EN**	**Clause**
7	**Assessment of halogens**					
7.1	- pH min.		4,3	4,3	50267-2-2	
7.2	- conductivity max.	µS/mm	10,0	10,0	50267-2-2	
7.3	- amount of halogen acid gas					
	- HCl and HBr max.	%	0,5	0,5	50267-2-1	
	- HF max. [d]	%	0,1	0,1	60684-2	
8	**Toxicity**				50305	9.2
	Toxicity index (ITC) max.		3	3		
9	**Acid and alkaline resistance**			N.A.	60811-2-1	10
9.1	Treatment - acid based: N oxalic acid soln. - alkaline based: N sodium hydroxide soln.					
	- temperature of bath	°C	23 ± 2			
	- duration	h	168			
9.2	Tensile strength: variation max.	%	± 30			
9.3	Elongation at break: min.	%	100			

[a] When tinned copper is used the operating temperature is limited to 120 °C.

[b] The test is only applicable to cables with O.D. ≤ 12,5 mm.

[c] The test is only applicable to cables with O.D. > 12,5 mm.

[d] This test need not be performed if a negative result is obtained for fluorine in the test given in B.3.3.

Table 3 – Requirements for the tests for halogen free sheathing compounds for Part 2

1	2	3	4	5	6	7	8
Ref No.	Test	Unit	Type of compound			Test method described in	
			EM 105 [a]	EM 106 [a]	EM 107 [b]	EN	Clause
1	**Mechanical properties**						
1.1	Properties in the state as delivered					60811-1-1	9.2
1.1.1	Values to be obtained for tensile strength:						
	- median. min.	MPa	10,0	10,0	8,0		
1.1.2	Values to be obtained for the elongation at break:						
	- median min.	%	125	125	200		
1.2	Long-term ageing				N.A.		
	- time	h	20 000	20 000		50305	7.3
	- temperature	°C	140	140			
1.3	Properties after ageing in air oven		N.A.	N.A.		60811-1-2	8.1
1.3.1	Ageing conditions:						
	- temperature	°C			200 ± 3		
	- duration of treatment	h			240		
1.3.2	Values to be obtained for the tensile strength:						
	- median. min.	MPa			6,0		
1.3.3	Values to be obtained for the elongation at break:						
	- median. min.	%			160		
2	**Hot set test**					60811-2-1	9
2.1	Conditions of treatment:						
	- temperature	°C	250 ± 3	250 ± 3	250 ± 3		
	- time under load	min	15	15	15		
	- mechanical stress	N/cm²	20	20	20		
2.2	Test requirements:						
	- max. elongation under load	%	100	100	100		
	- max. elongation after unloading	%	25	25	25		

Table 3 – Requirements for the tests for halogen free sheathing compounds for Part 2 *(continued)*

1	2	3	4	5	6	7	8
Ref No.	**Test**	**Unit**	**Type of compound**			**Test method described in**	
			EM 105 [a]	**EM 106** [a]	**EM 107** [b]	**EN**	**Clause**
3	**Water absorption** (gravimetric method)				N.A.	60811-1-3	9.2
3.1	Conditions of treatment: - water temperature - immersion duration	 °C h	 95 ± 2 24	 95 ± 2 24			
3.2	Test requirements: weight increase max.	mg/ cm²	15	15			
4	**Ozone resistance**					50305	7.4.2
4.1	Concentration Method A	 %	 (250-300) x 10^{-4}	 (250-300) x 10^{-4}	 (250-300) x 10^{-4}		
	Method B (alternative)	%	(200 ± 50) x 10^{-6}	(200 ± 50) x 10^{-6}	(200 ± 50) x 10^{-6}		
4.2	Test temperature Method A	 °C	 25 ± 2	 25 ± 2	 25 ± 2		
	Method B	°C	40 ± 2	40 ± 2	40 ± 2		
4.3	Test duration Method A	 h	 24	 24	 24		
	Method B	h	72	72	72		
4.4	Results to be obtained		No cracks	No cracks	No cracks		
5	**Mineral oil resistance**					60811-2-1	10
5.1	Treatment - type of oil: IRM902 - temperature: - duration:	 °C h	 100 ± 2 24	 100 ± 2 24	 100 ± 2 24		
5.2	Tensile strength: Variation max.	 %	 ± 30	 ± 30	 ± 25		
5.3	Elongation at break: Variation max.	 %	 ± 40	 ± 40	 ± 30		
6	**Bending test at low temperature** [c]					60811-1-4	8.2
6.1	Treatment: - temperature	 °C	 -25 ± 2	 -40 ± 2	 -40 ± 2		
6.2	Result to be obtained		No cracks	No cracks	No cracks		

Table 3 – Requirements for the tests for halogen free sheathing compounds for Part 2 *(continued)*

1	2	3	4	5	6	7	8
Ref No.	**Test**	**Unit**	**Type of compound**			**Test method described in**	
			EM 105 [a]	**EM 106** [a]	**EM 107** [b]	**EN**	**Clause**
7	**Elongation test at low temperature** [d]					60811-1-4	8.4
7.1	Treatment: - temperature	°C	-25 ± 2	-40 ± 2	-40 ± 2		
7.2	Elongation min.	%	30	30	30		
8	**Assessment of halogens**						
8.1	- pH min.		4,3	4,3	4,3	50267-2-2	
8.2	- conductivity max.	µS/mm	10,0	10,0	10,0	50267-2-2	
8.3	- amount of halogen acid gas						
	- HCl and HBr max.	%	0,5	0,5	0,5	50267-2-1	
	- HF max.[e]	%	0,1	0,1	0,1	60684-2	
9	**Toxicity**					50305	9.2
	Toxicity index (ITC) max.		3	3	3		
10	**Acid and alkaline resistance**					60811-2-1	10
10.1	Treatment - acid based: N oxalic acid soln. - alkaline based: N sodium hydroxide soln.						
	- temperature of bath	°C	23 ± 2	23 ± 2	23 ± 2		
	- duration	h	168	168	168		
10.2	Tensile strength: variation max.	%	± 30	± 30	± 30		
10.3	Elongation at break: min.	%	100	100	100		

[a] EM 105 and EM 106 are sheathing compounds for cables rated 120 °C.

[b] EM 107 is the sheathing compound for cable rated 150 °C.

[c] The test is only applicable to cables with O.D. ≤ 12,5 mm.

[d] The test is only applicable to cables with O.D. > 12,5 mm.

[e] This test need not be performed if a negative result is obtained for fluorine in the test given in B.3.3.

Annex A
(normative)

Requirements for halogens

A.1 Requirements for extruded material

The insulation and sheath shall meet the following requirements:

a) Type test

The material shall be tested to all the tests in Table A.1.

Table A.1 - Type test

	Test method	Measurement	Requirements
1	EN 50267-2-2	pH and conductivity	pH ≥ 4,3 and conductivity ≤ 10^4 μS m^{-1}
2	EN 50267-2-1	Chlorine and bromine content expressed as HCl	≤ 0,5 %
3a	EN 50382-1 Annex B	Halogen: Fluorine	If negative stop test; no further test needed. Accept material.
			If positive, do test according to 3b
3b	EN 60684-2	Fluorine content	≤ 0,1 %

b) Sample test

The material shall be tested to the sequential test programme in Table A.2.

Table A.2 - Sample test

	Test method	Measurement	Result	Outcome
Stage 0	EN 50382-1 Annex B	Halogen: Fluorine, Chlorine and Bromine		If negative stop test; no further test needed. Accept material
				If positive continue with stage 1
Stage 1	EN 50267-2-2	pH	< 4,3	Reject material
			≥ 4,3	Evaluate conductivity
		Conductivity	≤ 2,5 x 10^3 μS m^{-1}	Accept material. No further testing needed
		Conductivity	> 10^4 μSm^{-1}	Reject material
		Conductivity (s)	10^4 μS/m^{-1} ≤ s > 2,5 x 10^3 μS m^{-1}	Test to EN 50267-2-1
Stage 2	EN 50267-2-1	Chlorine and bromine Content expressed as HCl	> 0,5 %	Reject material
			≤ 0,5 %	Test to EN 60684-2
Stage 3	EN 60684-2	Fluorine content	> 0,1 %	Reject material
			≤ 0,1 %	Accept material

A.2 Requirements for non-extruded materials

Type and sample test

The materials shall meet the following requirements:

If the combined mass of all non-extruded materials (including separator tapes and fillers) is ≤ 5 % wt/wt of the total combustible material in the cable, the test to EN 50267-2-2 (Table A.1, No.1) shall be carried out on each component material. Each component shall meet the requirements for pH and conductivity of ≥ 4,3 and ≤ 10 μS/ m^{-1}, respectively.

A layer comprising a number of tapes of the same material shall be regarded as one component, and similarly, a number of cable fillers of the same material shall be regarded as one component.

If the combined mass of separator tapes and fillers is > 5 % wt/wt of the total combustible materials, then each of the components shall meet the requirements for extruded material according to Table A.1.

For the test according to 3a of Table A.1 the sample may be prepared from all tapes. If the result is positive it must be repeated on each component.

Annex B
(normative)

Determination of halogens – Elemental test

Warning

Owing to its potentially hazardous nature, the fusion operation should be carried out in a fume cupboard, using a safety screen.

A.3 Equipment

Bunsen burner;

3 small/medium soda glass test tubes (approximately 50 mm x 10 mm);

Test tube holder;

Evaporating basin/mortar;

Wire gauze;

Funnel;

Filter paper.

A.4 Materials

Unknown sample;

Sodium metal;

Dilute nitric acid (5 %);

Aqueous silver nitrate (5 %);

Dilute ammonia (10 %);

Freshly made up zirconium-alizarin red S reagent;

Glacial acetic acid;

Acid/pH indicator papers.

A.5 Procedure

Sodium fusion

Place 200 mg - 250 mg of the sample into the bottom of a small soda glass test tube. Add 10 ml of distilled/de-ionized water to the evaporating basin, and place this in the fume cupboard behind the safety screen. Whilst holding the test tube firmly with the test tube holder at an angle of 45° - 60° to the vertical, introduce a piece of freshly cut, clean, sodium (about the size of a small pea) (200 mg - 250 mg) into the mouth of the test tube, without allowing it to come into contact with the sample. With the safety screen in place, heat the sodium gently until it melts and runs down on to the sample, (there may be a vigorous reaction when the molten sodium reaches the sample, if halogens are present). Heat the tube gently for about 1 min, then more strongly until the lower 20 mm of the tube glows red hot. Plunge the red hot tube into the water in the evaporating basin, immediately placing the gauze on top (The gauze prevents any loss of material when the tube shatters on contact with the water). Allow any unreacted sodium to react before grinding up the solution and glass. Filter, and separate the filtrate into two equal portions.

Chlorine and bromine

To the first portion of the filtrate, add sufficient nitric acid to make the solution acidic. Boil this solution until its total volume has been reduced by half, (this is to remove any HCN or H_2S, if present, which would interfere with the test). Add 1 ml silver nitrate solution; a white or yellowish-white precipitate indicates the presence of halogen (Cl, Br) in the original sample. (If the liquor is decanted, and the precipitate is white and readily soluble in dilute ammonia, then chloride is present).

Fluorine

To the second portion of the filtrate, acidify with glacial acetic acid. Boil this solution until its total volume has been reduced by half. Add 2 – 3 drops freshly prepared zirconium lake reagent (equal volumes of a) Alizarin solution, 0,05 g Alizarin Red-S in 50 ml distilled water, b) Zirconium solution, 0,05 g zirconium nitrate in 10 ml concentrated HCl diluted with 50 ml distilled water). Heat at 40 °C for 1 h. The presence of fluoride is indicated by the red/pink colouration being bleached to yellow.

Annex C
(normative)

Thickness and overall diameter – Selection of samples and calculation of results

A.6 Insulation thickness

Procedure

The thickness of insulation shall be measured in accordance with EN 60811-1-1, 8.1. 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.

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.7 Measurement of sheath thickness

Procedure

The thickness of the sheath shall be measured in accordance with EN 60811-1-1, 8.2.

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

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.8 Measurement of overall diameter

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

The measurement of the overall diameter of any circular cable shall be carried out in accordance with EN 60811-1-1, 8.3.

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

Annex D
(informative)

Guidance on selection of cables for type approval

The selection of cables for type approval shall be made according to Table D.1.

Table D.1 – Selection of cables for type approval

Type	EN 50382-2 Table	Voltage	Select
Single, flexible unsheathed	1	1,8/3 kV	Three cables, - one ≤ 6 mm² - one cable ≥ 95 mm² - one cable selected from middle of range
Single, flexible sheathed	2	1,8/3 kV	As above
Single, flexible unsheathed	3	3,6/6 kV	As above
Single, flexible class 6 unsheathed	4	3,6/6 kV	One cable selected from middle of range
Single, flexible sheathed	5	3,6/6 kV	Three cables, - one ≤ 6 mm² - one cable ≥ 95 mm² - one cable selected from middle of range

NOTE The number of cables selected for type approval may be reduced by agreement between the purchaser and the manufacturer.

Bibliography

EN 50343	Railway applications – Rolling stock – Rules for installation of cabling
EN 50355	Railway applications – Railway rolling stock cables having special fire performance – Thin wall and standard wall – Guide to use
EN 60216 series	Electrical insulating materials - Thermal endurance properties (IEC 60216 series)

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