
**Železniške naprave – Požarna zaščita na železniških vozilih – 2. del: Zahteve
za obnašanje materialov in sestavnih delov v požaru**

(istoveten prEN 45545-2:2004)

Railway applications - Fire protection on railway vehicles - Part 2: Requirements for
fire behaviour of materials and components

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Bahnwendungen - Brandschutz in Schienenfahrzeugen - Teil 2: Anforderungen an das Brandverhalten

This draft European Standard is submitted to CEN and CENELEC members for enquiry. It has been drawn up by the Technical Committee CEN/CLC/WG FPR.

If this draft becomes a European Standard, CEN and CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Foreword

This document (prEN 45545-2:2004) has been prepared by Technical Committee CEN/TC 256 "Railway applications", the Secretariat of which is held by DIN, in cooperation with CENELEC/TC 9X "Electrical and electronic applications for railways".

This document is currently submitted to the parallel CEN/CENELEC Enquiry.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

- Council Directive 96/48/EC of 23 July 1996 on the Interoperability of the trans-European high-speed rail system¹⁾

CEN/TC 256/WG 1 and CENELEC/TC 9X / WG 3 started in 1991 with the elaboration of this European Standard. The co-ordination with other fire safety standardisation within CEN and CENELEC was carried out by CEN/BT/WG 50, Fire safety technology.

This series of European Standards EN 45545 "Railway applications — Fire protection on railway vehicles" consists of the following parts:

- Part 1: General
- Part 2: Requirements for fire behaviour of materials and components
- Part 3: Fire resistance requirements for fire barriers and partitions
- Part 4: Fire safety requirements for railway rolling stock design
- Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles
- Part 6: Fire control and management systems
- Part 7: Fire safety requirements for flammable liquid and flammable gas installations

¹⁾ Official Journal of the European Communities No L 235/6 of 17.09.96

Introduction

This European Standard is based on existing fire safety regulations for railway vehicles from the International Union of Railways (UIC) and different European countries.

In using the operation and design categories defined in prEN 45545-1, the requirements laid down in this part take into account the current operating conditions for European public rail transport.

1 Scope

This part of EN 45545 specifies the reaction to fire performance requirements for materials and products used on railway vehicles as defined in prEN 45545-1.

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 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests.*

prEN 45545-1, *Railway applications — Fire protection of railway vehicles — Part 1: General.*

prEN 45545-3:1998, *Railway applications — Fire protection of railway vehicles — Part 3: Fire resistance requirements for fire barriers and partitions.*

prEN 45545-5:2003, *Railway applications — Fire protection of railway vehicles — Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles.*

prEN 45545-6, *Railway applications — Fire protection of railway vehicles — Part 6: Fire control and management systems.*

EN 50266-1, *Common test methods for cables under fire conditions — Test for vertical flame spread of vertically-mounted bunched wires or cables — Part 1: Apparatus.*

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 50268-1, *Common test methods for cable under fire conditions — Measurement of smoke density of cables burning under defined conditions — Part 1: Apparatus.*

EN 50268-2, *Common test methods for cables under fire conditions — Measurement of smoke density of cables burning under defined conditions — Part 2: Procedure.*

EN 60529, *Degrees of protection provided by enclosures (IP code) (IEC 60529:1989).*

EN ISO 4589-2, *Plastics — Determination of burning behaviour by oxygen index — Part 2: Ambient-temperature test (ISO 4589-2:1996).*

EN ISO 5659-2, *Plastics — Smoke generation — Part 2: Determination of optical density by a single-chamber test (ISO 5659-2:1994, including Technical Corrigendum 1:1997)*

EN ISO 9239-1, *Reaction to fire tests for floorings — Part 1: Determination of the burning behaviour using a radiant heat source (ISO 9239-1:2002)*

EN ISO 11925-2, *Reaction to fire tests — Ignitability of building products subjected to direct impingement of flame — Part 2: Single-flame source test (ISO 11925-2:2002)*.

EN ISO 12952-3, *Textiles — Burning behaviour of bedding items — Part 3: General test methods for the ignitability by a small open flame (ISO 12952-3:1998)*.

EN ISO 12952-4, *Textiles — Burning behaviour of bedding items — Part 4: Specific test methods for the ignitability by a small open flame (ISO 12952-4:1998)*.

EN ISO 13943, *Fire safety — Vocabulary (ISO 13943:1999)*.

ISO 3261, *Fire tests; Vocabulary Bilingual edition*.

ISO 5660-1, *Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)*.

ISO 5658-2, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building products in vertical configuration*.

ISO 8421-1, *Fire protection; Vocabulary, Part 1: General terms and phenomena of fire Bilingual edition*.

ISO 9705, *Fire tests; full-scale room test for surface products*.

ISO 15540, *Ships and marine technology — Fire resistance of hose assemblies — Test methods*.

ISO/TR 9705-2, *Reaction-to-fire tests — Full-scale room tests for surface products — Part 2: Technical background and guidance*

ISO/DIS 19702, *Analysis of fire gases using Fourier infra-red technique (FTIR)*.

IEC/TS 60695-1-40, *Fire hazard testing — Part 1-40 : Guidance for assessing the fire hazard for electrotechnical materials — Insulating liquids*.

NF F 00-201, *Railway material in general — Antivandalism protection — Test method of laceration resistance, with a blade, of vandal-proof covering*.

NF X 70-100-1:2001 *Fire tests — Analysis of gaseous effluents — Part 1: Methods for analysing gases stemming from thermal degradation*.

3 Terms and definitions

3.1 Definition of parameters

3.1.1

Average Rate of Heat Emission (ARHE) and its Maximum (MARHE)

the Average Rate of Heat Emission at time t , $ARHE(t)$, is defined as the cumulative heat emission in the period $t=0$ to $t=t$ divided by t . The maximum value of the ARHE curve in the period $t=0$ to $t=t_{end}$ is defined as the Maximum Average Rate of Heat Emission (MARHE). MARHE can be applied to data in the form of kW vs time or kWm^{-2} vs time

ARHE can be generated as follows :

Given that the rate of heat emission data comprises pairs of data points where the first data point is (t_1, p_1) where t is the time and p is the rate of heat emission then $ARHE(t_n)$, (using a trapezoidal area assumption), is given by :

$$ARHE(t_n) = \frac{\sum_{n=2}^n \left((t_n - t_{n-1}) \times \frac{(p_n + p_{n-1})}{2} \right)}{t_n - t_1}$$

(Generally $t_1=0$ and $p_1=0$, or at least t can be rescaled to meet this condition and the expression can be further simplified).

This formula is derived from expressions for the heat for each time element and the summation of these elements as follows:

The heat for each time element, (h_n) , is calculated (the first heat element is derived from data points 1 and 2 and is assigned to data point 2; its designation is therefore h_2)

$$h_n = (t_n - t_{n-1}) \times \frac{(p_n + p_{n-1})}{2}$$

Summing these elements from $n=2$ to $n=n$ and dividing by the interval from t_1 to t_n generates $ARHE(t_n)$.

$$ARHE(t_n) = \frac{\sum_{n=2}^n h_n}{t_n - t_1}$$

3.1.2

Specific optical density – $D_s(n)$ standards.iteh.ai/catalog/standards/sist/895cfe72-0fc9-4298-9d24-44662020-2005
 this term is defined in EN ISO 5659-2. D_s is the specific optical density, (n indicates “at time n min into the test”)

The physical meaning of D_s is the optical density developed across opposite faces of a 1m cube when the smoke from 1m² of material is dispersed within the 1m cube. D_s is dimensionless.

3.1.3

VOF4 (Valeur obscurcissement fumée in 4 min)

VOF4 is the area under the D_s vs. time curve during the test period $t=0$ to $t=4$, using a trapezoidal area assumption and a finite element (t) of 1 min

$$VOF4 = \sum_{n=0}^{n=3} \frac{t(D_s(n) + D_s(n+1))}{2}$$

With $D_s(0)=0$ and $t=1$ this simplifies to:

$$VOF4 = D_s(1) + D_s(2) + D_s(3) + D_s(4)/2$$

VOF4 has dimensions of min.

3.1.4

Toxic measurement

Toxic fume requirements are defined in term of the Conventional Index of Toxicity (CIT). CIT has a specific meaning for specific materials/items but in all cases CIT comprises two terms:

$$CIT = [\text{Precursor Term}] \times [\text{Summation Term}]$$

CIT is always dimensionless and the Summation Term is generally produced from ratios of the emission level to the reference level of the gas components. For the scope of this European Standard the following 8 gas components shall be analysed : CO₂; CO; HF; HCL; HBr; HCN; S O₂;NO².

It may be assumed that the units of the Precursor Term are such as to generate a dimensionless CIT.

CIT – General (CIT)

The CIT is defined as follows:

$$CIT = 0.0805 \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

c_i = concentration of the i^{th} gas in the chamber (mgm^{-3}).

C_i = reference concentration ² of the i^{th} gas (mgm^{-3}).

CIT – Non-Listed Items (CIT_{NLI})

For non listed items there are two options for the determination.

Option 1 utilises the EN ISO 5659-2 chamber, option 2 utilises the NF X70-100-1 tube furnace

Option 1

The CIT_{NLI} measured with the smoke box is defined as follows:

$$CIT_{NLI} = \frac{362}{W} \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

c_i = concentration of the i^{th} gas in the chamber (mgm^{-3}).

C_i = reference concentration ² of the i^{th} gas (mgm^{-3}).

W = mass of 1m^2 of the material at 3mm thickness (g)

Option 2

The CIT_{NLI} measured with the tube furnace according to NF X70-100-1 with 8 gases is defined as follows :

$$CIT_{NLI} = 3 \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

c_i = measured emission of the i^{th} gas for (mgg^{-1}).

C_i = reference concentration of the i^{th} gas (mgm^{-3}).

CIT – Cable (CIT_C)

For a single combustible component within a cable, i.e. material (j) the contribution to CIT_C shall be calculated as follows. The calculation shall be carried out for each combustible component and the individual contributions summed to give the final CIT_C.

²) NO₂ includes both NO₂ and NO quoted as NO₂

For material 1:

$$CIT_c(j) = \frac{0.75 \times w(j)}{d} \times \sum_{i=1}^{i=8} \frac{c_i(j)}{C_i}$$

$c_i(j)$ = measured emission of the i^{th} gas for combustible material 1 (mgg^{-1}).

C_i = reference concentration of the i^{th} gas (mgm^{-3}).

$W(j)$ = mass of combustible material (j) per metre of cable (g)

d = cable diameter (mm)

The calculation shall be carried out for each combustible component (materials $j = 1$ to N) the individual contributions summed to give the final CIT_c

$$CIT_c = \sum_{j=1}^{j=N} CIT_c(j)$$

The reference concentrations C_i of the gas components in Table 1 shall be used.

Table 1 — Reference concentration of the gas components

Gas components	Reference concentration mgm^{-3}
CO ₂	72000
CO	1380
HF	25
HCl	75
HBr	99
HCN	55
NO ₂	38
SO ₂	262

NO₂ includes both NO₂ and NO quoted as NO₂

Both NO and NO₂ shall be measured. The mgm^{-3} of NO shall be multiplied by 46/30 to produce the equivalent mgm^{-3} of NO₂. The total NO₂ is given by the sum of the two values.

3.2 Explanation of expressions

Expressions used in this European Standard are explained on Table 2.

For fire terms and definitions used in this European Standard, see EN ISO 13943. The numbers indicated in column “references” refer to clauses within this European Standard.

Table 2 — Table of expressions

Expressions	Explanation	References
Armrest	An element which may function as a support for a seated person's arm but which may also be part of a seat which defines the width of a seat place. For testing purposes an armrest shall be considered to be formed from four surfaces including their substrates. Not all surfaces will be present for all types of armrest.	5.3.4
Coating	Product applied as liquid or powder to a substrate which will cure or dry into a continuous surface to the substrate.	
Composite	A combination of materials which are recognised in building construction as discrete entities, for example, coated, faced or laminated materials.	
Exterior of the body shell	If the path taken by the fire effluent to reach a passenger or staff area uses only space outside of the physical envelope of the vehicle, then the item or surface is exterior else the item or surface is interior. A gangway area between fire resisting vehicle ends is defined as an exterior area	
Homogeneous product	a product, consisting of a single material, having uniform density and composition throughout the product	
Listed item	Product included in the Table 3	4.2.2
Non listed item	Any item which is not listed in Table 3	4.2.3
Material	Single basic substance or uniformly dispersed mixture e.g. metal, stone, timber, concrete, mineral wool with uniformly dispersed binder polymers	
Non-homogeneous product	A product that does not satisfy the requirements of a homogeneous product.	
Product	The material, composite or assembly about which information is required.	
Limited Surfaces	For a listed item which is permitted to be a limited surface to be classified as a limited surface: The area shall be less than 0,25 m ² and : On a ceiling: - the maximum dimension in any direction on the surface shall be less than 1m and - the separation from another limited surface shall be greater than the maximum extent of the surface (measured horizontally in any direction on the surface) Or : On a wall: - the maximum dimension in a vertical direction shall be less than 1 m and - the separation from another limited surface shall be greater than the maximum extent of the surface (measured vertically) The total area of all limited surfaces on walls and ceilings (including windows and transverse partitions) within each passenger or staff compartment and each passenger or staff area, shall be less than 15 % of the total surface area of these walls and ceilings.	

Table 2 (continued)

Expressions	Explanation	References
Specimen	A specimen is a representative sample of the thing which is tested.	
Substrate	A material or materials which are used immediately beneath the product.	
Cable containment (linear products), limited	Cable containment placed in assemblies or equipment rooms. (considered to be a Non Listed item)	

4 Fire specific terminology

For the purposes of this European Standard, the following terms and definitions given in EN ISO 13943, ISO 3261 and ISO 8421-1 apply.

5 Requirement

5.1 Essential

The design of rolling stock and the materials used shall be aimed at limiting fire development should an ignition event occur.

According to different operation conditions, sizes of passenger areas and probable ignition sources, it shall be possible for passengers and staff to leave any area impacted by the products of fire unaided and to reach a place safety.

If it can be shown in agreement with the responsible certification body that any of the requirements specified are not technically achievable with functionally suitable materials, then it is acceptable to use "best available" products until and unless a suitable compliant material is developed.

5.2 Items requiring testing

5.2.1 General

There are two kinds of items defined:

- The "listed items" (requirements on 5.2.2)
- The "non-listed items" . (requirements on 5.2.3)

Both kinds of items shall be tested for their reaction to fire performance.

The principles on 5.2.3 apply to non listed items

The following principles applies to both kinds of items :

- The materials listed in Annex A are considered to comply with the highest level of reaction to fire performance within this part by definition.
- Items placed in technical cabinets, which are fitted with an automatic fire detection and fire extinguishing system, as defined in prEN 45545-6, may fulfil only the HL1 requirements, irrespectively of the hazard level of the vehicle / train.
The failure rate of the Automatic detection and extinguishing system to detect and respond to fire shall not be less or equal than 10⁻⁶.

- Machine compartments of vehicles, and any installations and equipment in this machine compartment, which are separated by at least a A1-15 fire barrier according to prEN 45545-3 from the cab or passenger areas, shall be treated as exterior applications.
- Mechanical or electric items, which are contained in an sealed, fire resisting enclosure may fulfil reduced requirements due to oxygen consumption or restriction according to the following rules:

No requirements with a defined sealing quality of IP 54 according to EN 60529.

and if the enclosure is made by a A2-5 fire barrier and the enclosed volume is $\leq 1 \text{ m}^3$

or if the enclosure is made by a A2-10 fire barrier and the enclosed volume is $\leq 2 \text{ m}^3$

or if the enclosure is made by a A1-30 fire barrier

NOTE Fire barriers A1 and A2 according to prEN 45545-3, but with 5, 10 or 30 min of fire resistance.

- For new build products the paints interior and exterior shall be tested in end use condition. To reduce testing effort, qualifying one colour is sufficient. Other colours of this paint system are qualified, without further testing

5.2.2 Requirement of listed items

The set of material requirements are listed in 5.3 and the short name of the set of material requirements is visible on the column "Requirement" on each listed item.

The column "Remarks" shows relationships to special requirements e.g. sample preparation , fire resistance.

OSIST prEN 45545-2:2005
 Table 3 — Requirements of listed items
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Item No	Name	Description	Requirement	Remark
IN	Interiors			
IN1	Interior components – horizontal downward facing surface; horizontal upwards facing; surfaces within cavities, walls – vertical surfaces	Interior components (structure and coverings) such as ceiling panelling as also flaps, boxes, hoods, louvers, and the body shell in this area. Interior components (structure and covering) such as side walls, front walls / end-walls, partitions, room dividers, as also flaps, boxes, hoods, louvers, in this area, interior doors, interior lining of the front-/end-wall doors and external doors, luggage area, windows (plastics, glazing with foils) also body shell in this area; kitchen interiors surfaces (except those of kitchen equipment)	R1	
IN2	Limited Surface	All listed items, which meet the requirements according to Table 2 column "limited surface " Exception : A limited surface with an area less than $0,1 \text{ m}^2$ may optionally be tested against R25 alternatively	R2	

Table 3 (continued)

Item No	Name	Description	Requirement	Remark
IN	Interiors			
IN3	Interior lighting	Lighting diffuser, light covering, covering for lamps (lamps itself and signal lamps are not within the scope)	R1	
IN4	Luggage rack	Overhead luggage racks, vertical luggage racks, luggage lockers	R1	
IN5	Driver's desk	Panelling and surfaces of the driver's desk.	R1	
IN6A	Interior surfaces of gangways Type A	Interior side of gangway membrane(below), interior lining of the gangway, (except flooring of the gangway) if there is no fire barrier at both bulk-head sides of the gangway	R1	
IN6B	Interior surfaces of gangways Type B	Interior side of gangway membrane(below), interior lining of the gangway,(except flooring of the gangway), if there is a fire barrier at both bulk-head sides of the gangway	R6	
IN 7	Window frame	Window frame	R1	
IN 8	Curtains and sunblind in passenger and staff areas, staff compartments	Curtains and sunblind except where enclosed within a double glassed window	R3	
IN10 A	Tables, folding tables top, including toilet wash basins	Upward surface of the tables or toilet wash basins and surrounds .	R2	
IN10 B	Tables, folding tables downward facing surface	Bottom surface of a table, the exposed vertical sides of drop down tables or any surface of a folding table that may become a bottom surface	R1	
IN 11	Container interior	Water container, air container.	R2	
IN12 A	Sound and thermal insulation material in wall and ceiling areas.		R1	
IN12 B	Sound and thermal insulation material in floor areas.		R2	
IN13 A	Interior surface of air ducts	Which are connected to the interior of the vehicle.	R1	
IN14 B	Exterior surface of air ducts	Which are interior installed to the vehicle	R1	
IN15	Air filter materials	Air filter materials for equipment ventilation heating and air conditioning	R4	

Table 3 (continued)

Item No	Name	Description	Requirement	Remark
IN	Interiors			
IN16	Devices for passenger info	Devices for passenger info This item can be a IN 2 requirements	R1	
IN17	Floor composite	Includes the floor substrate and floor covering in end use condition	R9	
EX	Exterior located			
EX 1	External body shell, walls	Vertical parts of external structure of body shell, cab housing and door leafs (including paint/coating systems, films)	R6	
EX 2	External body shell, roof	External roof structure of the car body (including paint/coating systems, films)	R7	
EX 3	External body shell, underframe	External surfaces of underframe structure of the body shell (floor) including paint and coating systems (thermal, design and acoustic coating) and protective floor panelling	R6	
EX 4	Exterior ducts	Exterior surface and interior surface of ducts which are not connected to the interior of the vehicle	R6	
EX 5	External design features	External design features (e.g. streamlining parts, ventilation grills, flaps, skirts, coverings for HVAC systems, enclosures, etc.)	R6	
EX 6A	Container exterior	Water container, air container placed in the underframe.	R6	
EX 6B	Container exterior	Water container, air container placed on the roof.	R7	
EX 7	Outer membrane of intercommunication gangways		R6	
EX 8	Bogie parts , structural	Bogie frames; spring leaf guide	R6	
EX 9	Air bags for pneumatic suspension	Air bags for pneumatic suspension	R8	
EX 11	Parts of the drive	Wheel sets , brake disc	R8	
EX12	Tyres		R6	