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

Applications ferroviaires - Protection contre les incendies dans les véhicules ferroviaires - Partie 2: Exigences du comportement au feu des matériaux et des composants

Bahnanwendungen - Brandschutz in Schienenfahrzeugen - Teil 2: Anforderungen an das Brandverhalten von Materialien und Komponenten

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Foreword

This document (EN 45545-2:2013) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2013, and conflicting national standards shall be withdrawn at the latest by March 2016.

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

This document supersedes CEN/TS 45545-2:2009.

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 2008/57/EC.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document.

This series of European standards *Railway applications — Fire protection on railway vehicles* consists of:

— Part 1: General;

— Part 2: Requirements for fire behaviour of materials and components;

— Part 3: Fire resistance requirements for fire barriers;

— 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.

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

EN 45545-2 has been developed from 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 EN 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 EN 45545-1.

The operation and design categories defined in EN 45545-1 are used to establish hazard levels that are used as the basis of a classification system.

For each hazard level, this part specifies the test methods, test conditions and reaction to fire performance requirements.

It is not within the scope of this European Standard to describe measures that ensure the preservation of the vehicles in the event of a fire.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13238, *Reaction to fire tests for building products — Conditioning procedures and general rules for selection of substrates*

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

EN 45545-1:2013, *Railway applications — Fire protection on railway vehicles — Part 1: General*

EN 45545-3, *Railway applications — Fire protection on railway vehicles — Part 3: Fire resistance requirements for fire barriers*

EN 45545-5:2013, *Railway applications — Fire protection on railway vehicles — Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles*

EN 50305:2002, *Railway applications — Railway rolling stock cables having special fire performance — Test methods*

EN 50306, *Railway applications — Railway rolling stock cables having special fire performance*

EN 50264, *Railway applications — Railway rolling stock power and control cables having special fire performance*

EN 50382, *Railway applications — Railway rolling stock high temperature power cables having special fire performance*

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 60332-3-24, *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 60584-1, *Thermocouples — Part 1: Reference tables*

EN 60695-2-11, *Fire hazard testing — Part 2-11: Glowing/hot-wire based test methods — Glow-wire flammability test method for end-products*

EN 60695-11-10, *Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods*

EN 61034-1, *Measurement of smoke density of cables burning under defined conditions — Part 1: Test apparatus*

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

EN ISO 1182, *Reaction to fire tests for products - Non-combustibility test (ISO 1182)*

EN ISO 1716:2010, *Reaction to fire tests for products — Determination of the gross heat of combustion (calorific value) (ISO 1716:2010)*

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

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

EN ISO 6507-3, *Metallic materials — Vickers hardness test — Part 3: Calibration of reference blocks (ISO 6507-3)*

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)*

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

EN ISO 12952-2, *Textiles — Assessment of the ignitability of bedding items — Part 2: Ignition source: match-flame equivalent (ISO 12952-2)*

ISO 5658-2:2006, *Reaction to fire tests — Spread of flame — Part 2: Lateral spread on building and transport products in vertical configuration*

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

ISO/TR 9705-2, *Reaction-to-fire tests — Full-scale room tests for surface products — Part 2: Technical background and guidance*ISO 11054, *Cutting tools — Designation of high-speed steel groups*

ISO 19702, *Toxicity testing of fire effluents — Guidance for analysis of gases and vapours in fire effluents using FTIR gas analysis*

ISO 2592, *Determination of flash and fire points — Cleveland open cup method*

ISO 2719, *Determination of flash point — Pensky-Martens closed cup method*

NF X70-100-1, *Fire tests — Analysis of gaseous effluents — Part 1: methods for analysing gases stemming from thermal degradation*

NF X70-100-2, *Fire tests — Analysis of gaseous effluents — Part 2: tubular furnace thermal degradation method.*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 45545-1:2013 apply.

4 Requirements

4.1 Essential fire safety objectives

The design of rolling stock and the products used shall incorporate the aim of limiting fire development should an ignition event occur so that an acceptable level of safety is achieved.

If the objectives defined in Clause 4 of EN 45545-1:2013 are met, then there should be a high probability that in the event of a fire, passengers and staff will be able to escape from the fire unaided and be able to reach a place of safety.

Hazard levels (HL 1 to HL 3) have been determined using a product of the relation between operation categories and design categories defined in EN 45545-1, as described in Table 1. Hazard levels are used in Table 5 for Material Fire Safety requirement classification.

Table 1 — Hazard level classification

Operation category	Design category			
	N: Standard vehicles	A: Vehicles forming part of an automatic train having no emergency trained staff on board	D: Double decked vehicle	S: Sleeping and couchette vehicles
1	HL1	HL1	HL1	HL2
2	HL2	HL2	HL2	HL2
3	HL2	HL2	HL2	HL3
4	HL3	HL3	HL3	HL3

4.2 General

The following principles are applicable to all products:

a) products which comply with the highest level of reaction to fire performance and therefore need no further testing are:

   — products classified as A1 according to EN 13501-1;

   — all products described in commission decision 96/603/EC (as amended);

b) products classified as A2 – s1, d0 according to EN 13501-1 are considered compliant with regard to flame spread, heat release and smoke emission requirements only. The toxic emissions limit shall satisfy the requirements of R1 HL3 (CIT<0,75);

c) electrical cables which satisfy the fire safety requirements of EN 50306, EN 50264 or EN 50382 are considered to satisfy the requirements of R15 and R16 for the corresponding hazard level (no further testing required);

d) where a product has a continuous aluminium or steel substrate and where the thickness of the substrate metal is equal to or greater than defined in Table 7, it is sufficient to test the product with the thickness given in Table 7;

e) a product, other than an electric cable, meeting a requirement at two different thicknesses with identical formulations shall be considered to comply with the requirement at all intermediate thicknesses. Electric

cables meeting a requirement at two different diameters with identical formulations shall be considered to comply with the requirement at all intermediate diameters;

f) a test which qualifies any product or surface shall also qualify any product or surface which differs in colour and/ or pattern;

g) multi layer products shall be tested in the end use condition;

h) mechanical or electrical products contained in a technical cabinet may be considered as unclassified products if:

- the technical cabinet satisfies the requirements of integrity criterion E10, based on the definitions described in EN 45545-1 and EN 45545-3 and the enclosed volume is $\leq 2\ m^3$;
- or the technical cabinet satisfies the requirements of integrity criterion E15 and insulation criterion I15 to surfaces adjacent to passenger area and staff area and integrity criterion E15 to other surfaces, based on the definitions described in EN 45545-1 with no volume limitations;
- or the technical cabinet is protected by an automatic fire detection and fire extinguishing system;

i) all coating systems shall be tested in end use condition. This means inclusion of levelling fillers at a thickness estimated at mean end use application, primers and finish coatings with specified coating thickness and number of layers;

j) where a coating (including vinyls, films and their adhesives) is applied to aluminium or steel in the end use condition and where the thickness of the metal is greater than those defined in Table 7 it is sufficient to test the coating on the reference substrate defined in Table 7;

k) for coatings applied to non metallic surfaces, the full specified test requirements are mandatory;

l) for products which are classified in Table 2 as IN2, IN3A, IN3B, IN10, IN11, EX1C, EX5, EX6A, EX6B, EX8, EX11, or EL2, where surfaces have organic coatings applied on metal or glass surfaces, ISO 5658-2 or EN ISO 9239-1 flame spread tests shall be carried out, but other test requirements such as heat release, smoke emission and toxic gas emission tests are not required if the nominal coating thickness, including any surfacing filler for exterior products is < 0,3 mm, or for interior products the nominal thickness of organic coating is < 0,15 mm;

m) if ISO 5658-2 is required as part of a requirement set, but the end use condition of a product does not allow preparation of test specimens to the size defined in ISO 5658-2, then in the case of interior use, R6 is applicable instead of the designated requirement set, and in the case of exterior use, R9 is applicable instead of the designated requirement set;

n) if listed products are used in an application below the mass and area thresholds given in 4.3, they may be treated as non-listed products.

4.3 Grouping rules

4.3.1 General

No requirements apply to products with a combustible mass of < 10 g not in touching contact with another unclassified product. To assess products the following parameters have to be considered. Products shall be considered as grouped if:

- the exposed area of each product is < 0,2 m^2; and
- they are not compliant to the applicable requirements of Table 2; and
- the combustible mass of each product is > 10 g or they are in touching contact to another combustible product; and

— the horizontal distance to a product non compliant to Table 2 is < 20 mm or the vertical distance to a product non compliant to Table 2 is < 200 mm; and

— they are not fully separated by a product compliant with the fire integrity requirement of 5.3.6.

The combustible masses of the products in this group shall be summed.

The assessment process described in 4.3.2 to 4.3.4 is visualized in the flow chart in Figure 1.

4.3.2 Rule 1

If the total combustible mass of the grouped products is

— < 100 g for interior grouped products;

or

— < 400 g for exterior grouped products;

no requirements apply to the products of this group.

4.3.3 Rule 2

If the combustible mass of the grouped products exceeds the limits stated in Rule 1, but is

— < 500 g for interior grouped products;

or

— < 2 000 g for exterior grouped products;

one combustible product of this group has to be tested according to R24.

If this product is compliant to R24 it shall not be considered for further assessment of this group. The remaining products in this group shall be assessed starting with Rule 1, 4.3.2, again.

4.3.4 Rule 3

If the combustible mass of the grouped products exceeds the limits stated in Rule 2, one product of the group shall be tested according to the requirements of non-listed products given in 4.5, Table 3.

If this product is compliant to the requirements of Table 3 it shall not be considered for further assessment of this group. The remaining products in this group shall be assessed starting with Rule 1, 4.3.2, again.

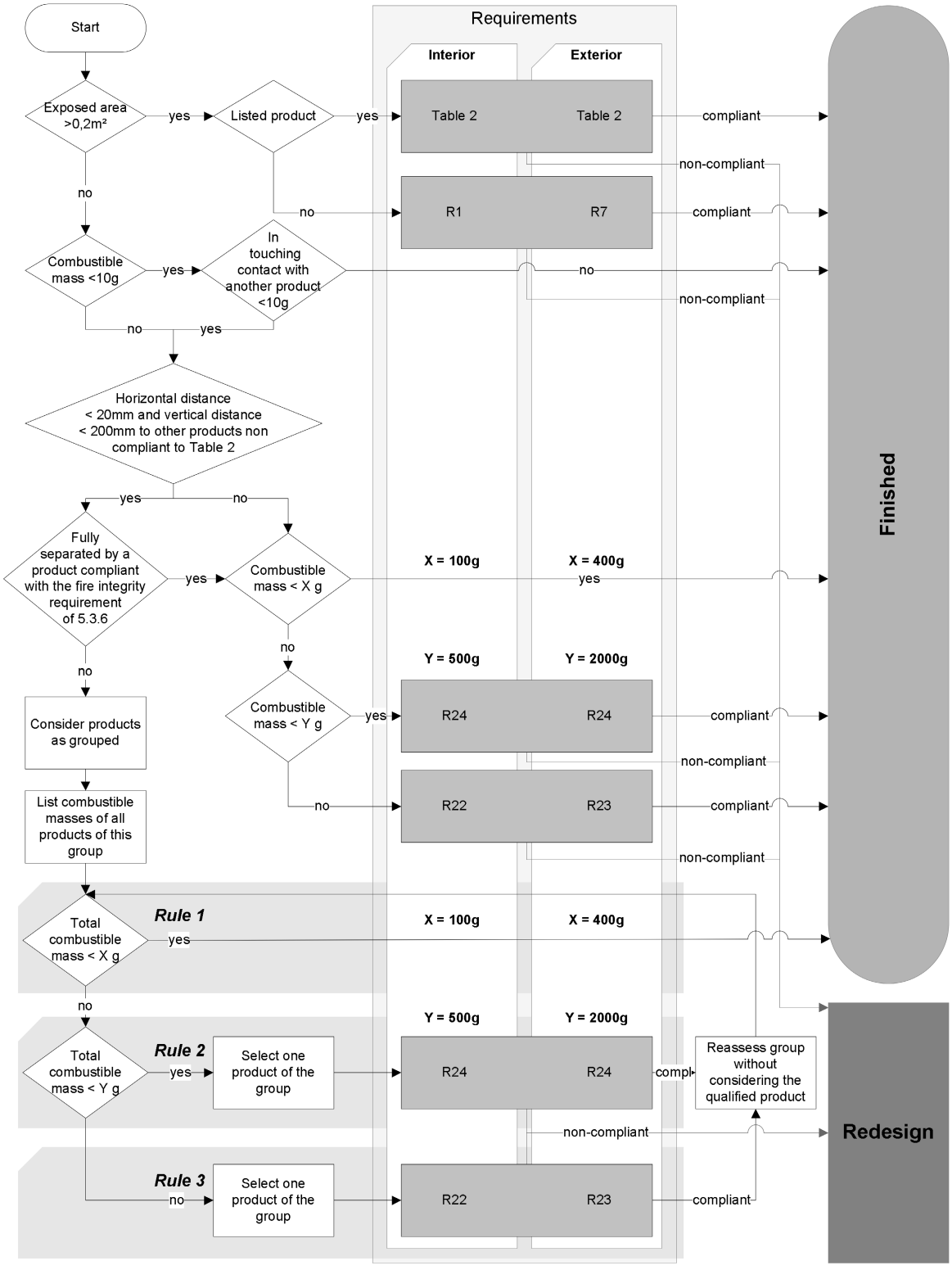


Figure 1 — Assessment process – Grouping rules

4.4 Listed products

The reaction to fire performance requirements of materials and components depend on their intrinsic nature but also:

— on the location of the materials or components within the design;

— on the shape and the layout of the materials;

— on the surface exposed and the relative mass and the thickness of the materials.

It is on this basis that the listed products have been classified and further differentiated into subgroups as follows:

— their general location (interiors or exteriors);

— their specific use (furniture, electrotechnical equipment or mechanical equipment).

Within the sub groupings, for each of the listed products, a set of requirements has been given which defines the ability of products to contain fire development to an appropriate degree considering the location, the exposed surfaces, their geometry and general disposition. Examples of different products are: ceiling panelling, floor composites, interior lighting, curtains, external body shell walls and underside and parts of the drive and suspension system.

The requirement sets for listed products are given in Table 2 and are designated R1 to R26. The content of each requirement set is listed in Table 5.

The column “Details” shows relationships to special requirements e. g. sample preparation and/or fire resistance.

Table 2 — Requirements of listed products *(1 of 7)*

Product No	Name	Details	Require-ment
IN	**Interiors**		
IN1A	Interior vertical surfaces	Interior components (structure and covering) such as side walls, front walls / end-walls, partitions, room dividers, flaps, boxes, hoods, louvres. Interior doors, interior lining of the front-/end-wall doors and external doors. Windows (including plastics and glazing) Insulation material and interior surface of body shell. Kitchen interior surfaces (except those of kitchen equipment).	R1
IN1B	Interior horizontal downward-facing surfaces	Interior components (structure and coverings) such as ceiling panelling, flaps, boxes, hoods, louvres. Insulation material and interior surface of body shell.	R1
IN1C	Interior horizontal upwards-facing surfaces	Interior components (structure and coverings) such as flaps, boxes, hoods, louvres. Insulation material and interior surface of body shell. Compliance with the requirements of R1 is also considered to be compliant for this requirement.	R10
IN1D	Interior surfaces within cavities	The surfaces may be horizontal or vertical.	R1
IN1E	External surfaces of enclosures containing technical equipment	Enclosures which are located inside the body shell NOTE Fire resistance requirements may apply to enclosures containing technical equipment – see 4.2 and EN 45545-3.	R1
IN2	Limited surfaces	— they shall have an area ≤ 0,20 m^2; — they shall have a maximum dimension in any direction on the surface ≤ 1 m; — they shall be separated from any other limited surface or strip by a distance of R1 compliant material greater than the dimension of the limited surface, measured in the same horizontal direction as the separation direction.	R2

Table 2 *(2 of 7)*

Product No	Name	Details	Require-ment
IN	**Interiors**		
IN3A	Strips	— they shall have a width < 200 mm and be separated from another limited surface or strip by > 200 mm of R1 compliant material; — they shall not have length limitation. For example, vertical cover strips on walls.	R3
IN3B	Light diffusers	For example, polycarbonate diffusers, light coverings for lamps. Light units themselves and indicators are not within the scope of IN3B.	R4
IN4	Luggage storage areas	Overhead luggage racks, vertical luggage racks, luggage stacks, luggage containers and luggage compartments.	R1
IN5	Driver's desk	Panelling and surfaces of the driver's desk (excluding electrical components/ equipment). [a]	R1
IN6A	Interior surfaces of gangways Type A – For railway vehicles in which there are no fire barriers at both bulk head ends of the gangway.	Interior side of gangway membrane (bellow), interior lining of the gangway, (except flooring).	R1
IN6B	Interior surfaces of gangways Type B – For railway vehicles in which there are fire barriers at both bulk head ends of the gangway.	Interior side of gangway membrane (bellow), interior lining of the gangway, (except flooring).	R7
IN7	Window frames	Window surround (including sealants and gaskets).	R1
IN8	Curtains and sunblind in passenger area and staff area, staff compartments	Curtains and sunblind except where they are enclosed within a double glazed window.	R1
IN9A	Tables, folding table tops, and toilet wash basins. Type A – Upper surfaces	All tables and toilet wash basins (including surrounds).	R2
IN9B	Tables, folding tables downward facing surface [b] Type B – Downward-surfaces	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
IN10	Containers	Outer surface of water containers and air containers.	R2
IN11	Litter bins and ashtrays	Inner and outer surfaces of litter bins and ashtrays.	R1
IN12A	Air ducts - Interior surfaces	Interior surfaces of ducts which are installed on the interior of the vehicle and from which air flows into the vehicle interior.	R1

Table 2 *(3 of 7)*

Product No	Name	Details	Require-ment
IN	**Interiors**		
IN12B	Air ducts – Exterior surfaces	Exterior surfaces of ducts which are installed in the interior of the vehicle, but from which air flows into the vehicle interior.	R1
IN12C	Air ducts on locomotives	Exterior and interior surfaces of ducts, which are located in technical areas and from which no air flows to the passenger area and staff area of a vehicle.	R7
IN13	Air filters	Materials for air filters used for equipment ventilation, heating and air conditioning.	R5
IN14	Devices for passenger information	Information display screens in passenger areas, not those in staff areas. Products such as speakers, handsets and their holders shall be considered as non-listed products	R1
IN15	Floor composites	The floor composites include the floor substrate (together with any thermal insulation) and floor covering (together with any fixings or adhesives applied in end use conditions).	R10
IN16	Interior seals	Longitudinal seals such as window seals, door joints and panel connections.	R22
EX	**Exterior located products**		
EX1A	Walls of external body shell	Vertical parts of external structure of body shell and door leafs (including paint/coating systems, films and windows).	R7
EX1B	Cab housing – External surfaces	Front of the train up to the cab partition (including paint/coating systems, films).	R17
EX1C	External surfaces of enclosures containing technical equipment	Enclosures which are located outside the body shell	R7
EX2	Roof of external body shell	External roof structure of the car body (including paint/coating systems, films). Compliance with the requirements of R7 is also considered to be compliant for this requirement.	R8
EX3	Under frame of external body shell	External surfaces of under frame structure of the body shell (floor) including paint and coating systems (thermal, design and acoustic coating) and protective floor panelling.	R7
EX4	Exterior ducts	Exterior and interior surfaces of ducts which are not connected to the interior of the vehicle	R7

Table 2 *(4 of 7)*

Product No	Name	Details	Require-ment
EX	**Exterior located products**		
EX5	External design features	External design features (e. g. streamlining parts, ventilation grills, flaps, skirts, coverings for HVAC systems, enclosures, etc.)	R7
EX6A	Containers mounted in under frame	Outer surfaces of water containers and air containers which are positioned in the under frame.	R7
EX6B	Containers mounted on roof	Outer surfaces of water containers and air containers which are positioned on the roof. Compliance with the requirements of R7 are also considered to be compliant to this requirement.	R8
EX7	Exterior surfaces of gangways	Outer membrane of intercommunication gangways.	R7
EX8	Bogie structure and parts	The bogie structure shall include frames, spring leaf guides and bolster.	R7
EX9	Air bags for pneumatic suspension		R9
EX10	Parts of the drive	Wheel sets and brake discs.	R9
EX11	Tyres		R9
EX12	Exterior seals	Longitudinal seals such as window seals, door joints and panel connections	R23
F	**Furniture**		
F1 [c]	Complete passenger seats	Complete passenger seat, including seat shell, upholstery, arm and head rests. Tip-up seats and driver's seat (if it is accessible to passengers) are also included. Details of seat tests (including the conditions for vandalism testing) are given in Annex A and Annex B.	R18
F1A	Upholstery for passenger seats and head rest	Upholstery includes the trimming (e. g. suspension system), flexible foam core, intermediate layers (e. g. fire barrier, anti-vandal layer), seat covers (e. g. base, back, side cover) and head rest upholstery. Details of test specimen preparation are given in Annex D.	R21

Table 2 *(5 of 7)*

Product No	Name	Details	Require-ment
F	**Furniture**		
F1B	Armrests for passenger seats	The surface on which the arm rests shall be tested. In addition, the downwards facing and vertical surfaces in the normal operating position shall comply with the requirements of 5.2.2.2 Fire integrity. Details of test specimen preparation are given in Annex D..	R21
F1C	Passenger seat shell - Base	The external surface of the base shell (including all coatings or coverings) shall be tested. Compliance with 5.2.2.2 Fire Integrity is also required.	R6
F1D	Passenger seat shell - Back	The external surface of the back shell (including all coatings or coverings) shall be tested. Compliance with 5.2.2.2 Fire Integrity is also required.	R6
F1E	Removable head rest	Removable head rests shall be tested as if they were loose cushions.	R21
F2	Seats in staff areas	Staff seat upholstery and supporting structure (including the back/base shell) shall be tested according to the following conditions: — top surface of seat; — back shell from external surface; — external surface of base shell. Test in the end use conditions referring to guidance in Annex D. If the fire integrity condition of 5.2.2.2 is additionally met, then it is not necessary to test the shell/upholstery composite from the shell face. Whole seat is qualified if the requirement set R19 is met. No further tests required.	R19
F3	Mattresses	Details of test specimen preparation are given in Annex D.	R21
F4	Loose upholstery items for seats, couchettes and beds	Bed clothes for couchettes and beds (cushions, blankets, duvets, pillows, sleeping bags and sheets, etc). Antimaccassars shall be considered as non-listed products.	R20
F5	Underside surface of couchettes and beds	Compliance with 5.2.2.2 Fire integrity is also required.	R1

Table 2 *(6 of 7)*

Product No	Name	Details	Require-ment
E	**Electrotechnical equipment**		
EL1A	Cables for interior	Cables not compliant with one of the standards referenced in 4.2c	R15
EL1B	Cables for exterior	Cables not compliant with one of the standards referenced in 4.2c	R16
EL2	Cable containment (linear product)	Cable containment surface related (cable duct, cable conduit). See 5.3.5	See Table 8 and Table 9
EL3A	Arc resistant insulation materials Type A	See 5.3.2 in EN 45545-5:2013.	R11
EL3B	Arc resistant insulation materials Type B	See 5.3.3 in EN 45545-5:2013.	R12
EL3C	Arc splash barrier materials	See 5.3.1 in EN 45545-5:2013.	R7
EL4	Flammable insulation liquid		R14
EL5	Supply line system devices – Exterior	Surge arresters; isolators; switches; main circuit breakers	R23
EL6A	Supply line system and high power devices - Interior	Isolators; current and voltage transformers, main circuit breakers; contactors	R22
EL6B	Supply line system and high power devices – Exterior	Isolators; current and voltage transformers, main circuit breakers; contactors	R23
EL7A	Choke and coils – Interior	Chokes for supply line filtering, coils for air cooled transformers, including spacers and air guiding plates	R22
EL7B	Choke and coils – Exterior	Chokes for supply line filtering, coils for air cooled transformers, including spacers and air guiding plates and traction motor winding insulation	R23
EL8	Brake resistors	Casing and any heat shields	R13
EL9	Printed circuit boards	Printed circuit boards without any attached technical equipment	R24 or R25
EL10	Small electrotechnical products	Examples include low power circuit breakers, overload relays, contactors, contactor relay, switches, control or signalling switches, terminals, fuses	R26

Table 2 *(7 of 7)*

Product No	Name	Details	Require-ment
M	**Mechanical equipment**		
M1	Flexible metal/rubber units	Flexible metal/rubber units including elements in bogies	R9
M2	Hoses - Interior	Pipes and hoses for fuel, oils, hydraulics, pneumatics, water and drainage	R22
M3	Hoses - Exterior	Pipes and hoses for fuel, oils, hydraulics, pneumatics, water and drainage	R23

[a] Computer screens will be assessed as limited surface, IN2 and not assessed as electrical equipment.

[b] Downward facing surfaces up to 0,2 m^2 of folding tables shall be assessed according to the requirements of R2.

[c] When assessing a seat design, results from all F1 tests (F1, F1A, F1B, F1C, F1D, F1E) are required for complete validation (except driver's seat).

4.5 Non-listed products

Any product not listed in Table 2 shall be considered as a non-listed product or shall be assessed using the grouping rules stipulated in 4.3.

The requirements of non-listed products are given in Table 3.

Table 3 — Requirements for non-listed products according to the exposed area and location in the vehicle

Exposed area	Location	Requirement set in Table 5
> 0,20 m^2	interior	R1
> 0,20 m^2	exterior	R7
≤ 0,20 m^2	interior	R22
≤ 0,20 m^2	exterior	R23

4.6 Refurbishment and maintenance requirements

4.6.1 General

In accordance with EN 45545-1, it shall be ensured that components introduced during maintenance and refurbishment shall comply with relevant material requirements as described below.

After refurbishment it shall be demonstrated that any new surface generated by any over-coating or over-laminating process does not have a worse classification than the original surface.

At the time of refurbishment of a railway vehicle, it might be difficult to obtain the original substrate. Therefore, it is recommended to identify an equivalent substrate that can represent the performance of the original substrate.

On trains built and approved according to this standard any new components introduced during refurbishment shall be verified to the requirements of Clause 4.

For trains built and already approved to previous standards and regulations, e. g. national standards or UIC leaflets, the following applies:

— minor adjustments during maintenance as a consequence of product and market development on components may be performed to the already approved set of standards and regulations for the relevant train at the time of its approval;

— refurbishment projects shall take into account the guidelines of this standard, and the new components introduced shall be documented against any relevant acceptance criteria in 4.2.

4.6.2 Requirements for refurbishment of passenger seats

Some of the parameters that may influence fire behaviour are:

— seat construction;

— individual material composition;

— shape;

— thickness, density, mass;

— supplier.

Table 4 specifies the test requirements for changes to only one of these parameters for upholstery for passenger seats.

Refurbished passenger seats, which have changes to more than one of the parameters listed in Table 4, shall be tested to the full requirements according to Table 2.

Table 4 — Test requirements for the upholstery of refurbished passenger seats.

Parts	Parameters changed	Requirements
Cover	Supplier only	R21 (Upholstery assembly)
Interlayer (fire barrier)	Supplier only	R21 (Upholstery assembly)
Glue	Composition nature, supplier	R21 (Upholstery assembly)
Foam	Certified thickness difference less than ± 15 %	None
	Certified thickness difference more than ± 15 % or new foam material	R18 (Complete Seat)

4.7 Products to be approved on functional necessity

If it can be shown that any of the requirements specified above are not technically achievable with functionally suitable products, then existing commercially available products can be used until and unless a suitable product is developed. There shall be no requirement to consider products made available after the date of the contract.

The use of this paragraph has the following conditions:

— essential requirements in 4.1 shall not be compromised;

— this shall be verified by assessment; taking the proposed design into consideration; including the functional reason and limitation for using the material in question (e. g. climate and/or infrastructure).

NOTE It can be necessary to use this process in respect of products such as:

rubber tyres; rubber suspension components; intercommunication gangways, electronics devices on printed board, flexible metal/rubber units; window seals; seals for doors; brake hoses; pneumatic hoses; flexible fuel hoses; high voltage cables; data bus cables, the anti-spall layer for windscreens on the driver's cab, windscreen washer water containers.

4.8 Set of material requirements

Material requirements are listed in Table 5. A reported result is compliant if it is equal to the requirement after rounding to the specified requirement level plus 1 digit.

The column "Test method reference" refers to the corresponding number in Table 6, where the test methods are described in more detail with a short explanation of the test-method, parameter and unit including whether the numerical value in the tables of requirements represents a maximum or minimum for compliance.

Where no requirement is specified in the tables of requirements the symbol "-" is inserted.

Table 5 — Material requirement sets *(1 of 9)*

Requirement set (relevant product no.)	Test method reference	Parameter and unit	Maximum or Minimum	HL1	HL2	HL3
R1 (IN1A; IN1B; IN1D; IN1E; IN4; IN5; IN6A; IN7; IN8; IN9B; IN11; IN12A; IN12B; IN14; F5)	T02 ISO 5658-2	*CFE* kWm^{-2}	Minimum	20 [a]	20 [a]	20 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	[a] -	90	60
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	600	300	150
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	1 200	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R2 (IN2; IN9A; IN10)	T02 ISO 5658-2	*CFE* kWm^{-2}	Minimum	13 [a]	13 [a]	13 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	[a] –	[a] –	90
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	600	300	150
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	1 200	600	300

Table 5 *(2 of 9)*

Requirement set (relevant product no.)	Test method reference	Parameter and unit	Maximum or Minimum	HL1	HL2	HL3
R2 (IN2; IN9A; IN10)	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R3 (IN3A)	T02 ISO 5658-2	CFE kWm^{-2}	Minimum	13 [a]	13 [a]	13 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	[a] –	[a] –	[a] –
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	–	480	240
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	–	960	480
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R4 (IN3B)	T02 ISO 5658-2	CFE kWm^{-2}	Minimum	13	13	13
	T05 EN ISO 11925-2 30 s flame application	Flame spread mm	Maximum	150 (within 60 s)	150 (within 60 s)	150 (within 60 s)
	T05 EN ISO 11925-2 30 s flame application	Flaming droplets		0	0	0
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75

Table 5 (*3 of 9*)

Requirement set (relevant product no.)	Test method reference	Parameter and unit	Maximum or Minimum	HL1	HL2	HL3
R5 (IN13)	T05 EN ISO 11925-2 30 s flame application	Flame spread mm	Maximum	150 (within 60 s)	150 (within 60 s)	150 (within 60 s)
	T03.02 ISO 5660-1: 25 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	50	50	50
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	300	250	200
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R6 (F1C; F1D)	T03.01 ISO 5660-1: 50 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	90	90	60
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	600	300	150
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	1 200	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R7 (IN6B; IN12C; EX1A; EX1C; EX3; EX4; EX5; EX6A; EX7; EX8; EL3C)	T02 ISO 5658-2	CFE kWm^{-2}	Minimum	20 [a]	20 [a]	20 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	[a] –	90	60
	T10.04 EN ISO 5659-2: 50 kWm^{-2}	D_s max. dimensionless	Maximum	–	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	–	1,8	1,5

Table 5 (*4 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R8 (EX2; EX6B)	T04 EN ISO 9239-1	*CHF* kWm^{-2}	Minimum	4,5	6	8
	T03.02 ISO 5660-1: 25 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	–	50	50
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	–	600	300
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	–	1,8	1,5
R9 (EX9; EX10; EX11; M1)	T03.02 ISO 5660-1: 25 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	90	90	60
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	–	600	300
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	–	1,8	1,5
R10 (IN1C; IN15)	T04 EN ISO 9239-1	*CHF* kWm^{-2}	Minimum	4,5	6	8
	T03.02 ISO 5660-1: 25 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	–	–	–
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	600	300	150
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75

Table 5 (*5 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R11 (EL3A)	T02 ISO 5658-2	CFE kWm^{-2}	Minimum	30 [a]	30 [a]	30 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	90	90	60
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	600	300	150
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	1 200	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R12 (EL3B)	T02 ISO 5658-2	CFE kWm^{-2}	Minimum	40 [a]	40 [a]	40 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	60	60	60
	T10.01 EN ISO 5659-2: 50 kWm^{-2}	$D_s(4)$ dimensionless	Maximum	600	300	150
	T10.02 EN ISO 5659-2: 50 kWm^{-2}	VOF_4 min	Maximum	1 200	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R13 (EL8)	T14 EN 13501-1	Euroclass	Minimum	A1	A1	A1
R14 (EL4)	T08 ISO 2592 ISO 2719	Class K Fire point °C	Minimum	300	300	300

Table 5 (*6 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R15 (EL1A)	T09.01 EN 60332-1-2	Unburned length mm	Minimum	burned part ≤ 540 and unburned part > 50	burned part ≤ 540 and unburned part > 50	burned part ≤ 540 and unburned part > 50
	T09.02 EN 60332-3-24 (for d ≥ 12 mm)	m	Maximum	2,5	2,5	2,5
	T09.03 EN 50305 (for 6 mm < d < 12 mm)	m	Maximum	2,5	2,5	2,5
	T09.04 EN 50305 (for d ≤ 6 mm)	m	Maximum	1,5	1,5	1,5
	T13 EN 61034-2	Transmission %	Minimum	25	50	70
	T15 EN 50305	*ITC* dimensionless	Maximum	10	10	6
R16 (EL1B)	T09.01 EN 60332-1-2	Unburned length mm	Minimum	burned part ≤ 540 and unburned part > 50	burned part ≤ 540 and unburned part > 50	burned part ≤ 540 and unburned part > 50
	T09.02 EN 60332-3-24 (for d ≥ 12 mm)	m	Maximum	2,5	2,5	2,5
	T09.03 EN 50305 (for 6 mm < d < 12 mm)	m	Maximum	2,5	2,5	2,5
	T09.04 EN 50305 (for d ≤ 6 mm)	m	Maximum	1,5	1,5	1,5
	T13 EN 61034-2	Transmission %	Minimum	-	25	50
	T15 EN 50305	*ITC* dimensionless	Maximum	10	10	6

Table 5 (*7 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R17 (EX1B)	T02 ISO 5658-2	*CFE* kWm^{-2}	Minimum	13 [a]	13 [a]	13 [a]
	T03.01 ISO 5660-1: 50 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	[a] –	90	60
	T10.04 EN ISO 5659-2: 50 kWm^{-2}	D_s max. dimensionless	Maximum	–	600	300
	T11.01 EN ISO 5659-2: 50 kWm^{-2}	CIT_G dimensionless	Maximum	–	1,8	1,5
R18 [b] (F1)	T06 ISO/TR 9705-2	*MARHE* kW	Maximum	75	50	20
	T06 ISO/TR 9705-2	*RHR Peak* kW	Maximum	350	350	350
R19 (F2)	T03.02 ISO 5660-1: 25 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	75	50	50
R20 (F4)	T07 EN ISO 12952-2	After burning time s	Maximum	10	10	10
	T03.02 ISO 5660-1: 25 kWm^{-2}	*MARHE* kWm^{-2}	Maximum	50	50	50
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	200	200	200
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	0,75	0,75	0,75

Table 5 (*8 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R21 (F1A; F1B; F1E; F3)	T03.02 ISO 5660-1: 25 kWm^{-2}	$MARHE$ kWm^{-2}	Maximum	75	50	50
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	300	300	200
	T11.02 EN ISO 5659-2: 25 kWm^{-2}	CIT_G dimensionless	Maximum	1,2	0,9	0,75
R22 (IN16; EL2; EL6A; EL7A; M2)	T01 EN ISO 4589-2: OI	Oxygen content %	Minimum	28	28	32
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	600	300	150
	T12 NF X 70-100-1 and -2 600 °C	CIT_{NLP} dimensionless	Maximum	1,2	0,9	0,75
R23 (EX12; EL2; EL5 EL6B; EL7B; M3)	T01 EN ISO 4589-2: OI	Oxygen content %	Minimum	28	28	32
	T10.03 EN ISO 5659-2: 25 kWm^{-2}	D_s max. dimensionless	Maximum	–	600	300
	T12 NF X 70-100-1 and - 2 600 °C	CIT_{NLP} dimensionless	Maximum	–	1,8	1,5

Table 5 (*9 of 9*)

Short name of requirement set (used for)	Test method reference	Parameter Unit	Maximum or Minimum	HL1	HL2	HL3
R24	T01 EN ISO 4589-2: OI	Oxygen content %	Minimum	28	28	32
R25 (EL9)	T16 EN 60695-2-11	Glow Wire Temperature °C	Minimum	850	850	850
R26 (EL10)	T17 EN 60695-11-10	Vertical small flame test	Minimum	V0	V0	V0

[a] If flaming droplets/particles are reported according to 5.3.7 during the test ISO 5658-2, or for the special case of materials which do not ignite in ISO 5658-2 and are additionally reported as unclassifiable, the following requirements shall be added:

Test to the requirements of EN ISO 11925-2 with 30 s flame application.

The acceptance requirements are:

— flame spread < 150 mm within 60 s;

— no burning droplets/particles.

[b]

— during the test, the flame spread shall not reach the edges of the seat surface or the backrest;

— during the test, the flame height above the highest point of the seat surface shall not exceed 1 000 mm;

— if the peak heat release values are too high for test equipment safety then the product is not compliant.

5 Test properties

5.1 Summary of test methods

Table 6 gives a summary of referenced test methods.

Table 6 — Summary of test methods *(1 of 6)*

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T01	EN ISO 4589-2	Determination of burning behaviour by oxygen index Part 2: Ambient temperature test	*OI*	Usually reported as '% oxygen'	Minimum	*OI* is the abbreviation for Oxygen Index
T02	ISO 5658-2	Lateral flame spread	*CFE*	kW/m^{-2}	Minimum	*CFE* is the abbreviation for Critical Flux at Extinguishment
T03.01	ISO 5660-1	Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)	*MARHE*	kW/m^{-2}	Maximum	*MARHE* is the maximum average rate of heat emission. The data collection interval shall be 2 s and data collection shall be terminated at 20 min. The heat flux shall be 50 kW/m^2 5.3.6 is also applicable where specified Results of *ARHE* and *MARHE* are expressed in units of kW/m^2 (heat emission rate per unit area)

Table 6 (*2 of 6*)

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T03.02	ISO 5660-1	Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method)	*MARHE*	kW/m^{-2}	Maximum	*MARHE* is the maximum average rate of heat emission The data collection interval shall be 2 s and data collection shall be terminated at 20 min The heat flux shall be 25 kW/m^2 5.3.6 is also applicable where specified. Results of *ARHE* and *MARHE* are expressed in units of kW/m^2 (heat emission rate per unit area)
T04	EN ISO 9239-1	Radiant panel test for horizontal flame spread of floorings	*CHF*	kW/m^{-2}	Minimum	*CHF* is the Critical Heat Flux at extinguishment.
T05	EN ISO 11925-2	Ignition when subjected to direct impingement of flame	30 s flame application		No spread > 150 mm within 60 s	
T06	ISO/TR 9705-2	Furniture calorimeter vandalised seat	*MARHE*	kW	Maximum	*MARHE* is the maximum average rate of heat emission Annex B Results of *MARHE* are expressed in units of kW

Table 6 (*3 of 6*)

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T07	EN ISO 12952-2	Textiles – Assessment of the ignitability of bedding items – Part 2: Ignition source: match-flame equivalent	Afterburn time	s	Maximum	No ignition is defined as follows: — sustained flaming less than 10 s — no flames reaching any edge of the specimen
T08	ISO 2592 ISO 2719	*Determination of flash and fire points – Cleveland open cup method*	Class K Fire point	°C	Minimum	
T09.01	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	Height of charred zone and height of unburned zone	mm	Length of unburned cable > 50 mm	Preliminary test for all cables Definitions of the “burned part” and “unburned part” are given in Annex A of the test method
T09.02	EN 60332-3-24	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	Height of charred zone front side and backside	m	Maximum 2,5	Test for cables with $D \geq$ 12 mm
T09.03	EN 50305:2002, 9.1.1	Railway applications — Railway rolling stock cables having special fire performance — Test methods	Height of charred zone front side and backside	m	Maximum 2,5	Test for cables with 6 mm < D < 12 mm

Table 6 (*4 of 6*)

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T09.04	EN 50305:2002, 9.1.2	Railway applications — Railway rolling stock cables having special fire performance — Test methods	Height of charred zone front side and backside	m	Maximum 1,5	Test for cables with D ≤ 6 mm
T10.01	EN ISO 5659-2	Plastics — Smoke generation Part 2: Determination of optical density by a single-chamber test	D_s (4) see 3.1.3	dimensionless	Maximum	Heat flux 50 kW/m^2 without pilot flame. Test duration is 10 min. D_s (4) is the optical density in the test chamber 4 min into the test multiplied by a factor, which depends on the instrument and on the specimen size.
T10.02	EN ISO 5659-2	Plastics — Smoke generation Part 2: Determination of optical density by a single-chamber test	VOF_4 see 3.1.4	min	Maximum	Heat flux 50 kW/m^2 without pilot flame. Test duration is 10 min. VOF_4 is the cumulative value of specific optical densities in the first 4 min of the test.

Table 6 (*5 of 6*)

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T10.03	EN ISO 5659-2	Plastics — Smoke generation Part 2: Determination of optical density by a single-chamber test	D_s max see 3.1.3	dimensionless	Maximum	D_s max is the maximum optical density in the test chamber. Test duration is 10 min. Heat flux 25 kW/m^2 with pilot flame
T10.04	EN ISO 5659-2	Plastics — Smoke generation Part 2: Determination of optical density by a single-chamber test	D_s max see 3.1.3	dimensionless	Maximum	D_s max is the maximum optical density in the test chamber. Test duration is 10 min. Heat flux 50 kW/m^2 without pilot flame
T11.01	EN 45545-2:2013 Annex C	Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique	CIT_G at 4 and 8 min	dimensionless	Maximum	CIT is the Conventional Index of Toxicity Heat flux 50 kW/m^2 without pilot flame. Test duration is 10 min.

Table 6 (*6 of 6*)

Ref.	Standard	Short description	Parameter	Unit	Test Criteria	Additional explanation
T11.02	EN 45545-2:2013 Annex C	Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique	CIT_G at 4 and 8 min	dimensionless	Maximum	CIT is the Conventional Index of Toxicity Heat flux 25 kW/m^2 with pilot flame. Test duration is 10 min.
T12	NF X70-100-1 NF X70-100-2	Gas analysis for the 8 gases described on 3.1.5	CIT_{NLP}	dimensionless	Maximum	Furnace Temperature 600 °C Toxic for non-listed products
T13	EN 61034-2	Measurement of smoke density of cables burning under defined conditions — Part 2: Test procedure and requirements	Transmission	dimensionless Transmission is reported as a percentage.	Minimum	Apparatus used is described in EN 61034-1
T14	EN 13501-1	Fire classification of construction products and building elements — Part 1: Classification using test data from reaction to fire tests	Table 1	dimensionless classification	Minimum	Classification according to EN ISO 1182 and EN ISO 1716:2010 A.1 and A.2
T15	EN 50305	Railway applications — Railway rolling stock cables having special fire performance — test methods	ITC	dimensionless classification	Maximum	
T16	EN 60695-2-11	Fire hazard testing — Part 2-11: Glowing/hot-wire based test methods Glow-wire flammability test method for end-products	Glow wire temperature	°C	Minimum	
T17	EN 60695-11-10	Fire hazard testing — Part 11-10: Test flames — 50 W horizontal and vertical flame test methods	Vertical small flame test	dimensionless classification	Minimum	

5.2 Modifications on test methods used in 5.1

5.2.1 Definitions

5.2.1.1 *ARHE*

ARHE is generated as follows:

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

$$ARHE(t_n) = \frac{\sum_{2}^{n}(t_n - t_{n-1}) \times \frac{\dot{q}_n + \dot{q}_{n-1}}{2}}{t_n - t_1}$$

Generally t_1 = 0 and q_1 = 0, or at least t can be rescaled to meet this condition; the expression above can be further simplified.

The heat emission for each time element (h_n) is calculated assuming a scan rate at 2 s (ISO 5660-1). The first heat element is obtained from data points 1 and 2 and assigned to data point 2 as h_2:

$$h_n = (t_n - t_{n-1}) \times \frac{\dot{q}_n + \dot{q}_{n-1}}{2}$$

Summing these elements from n = 2 to n = n and dividing by the interval of time from t_1 to t_n:

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

5.2.1.2 VOF_4

It is the area under a $D_S(n)$ versus time curve during the test period t = 0 min to t = 4 min, with $D_S(0)$ = 0, a finite element (dt) of 1 min, and using a trapezoidal area assumption

VOF_4 = [D_s (1) + D_s (2) + D_s (3) + D_s (4) /2] × 1 min

VOF_4 has dimensions of minutes.

5.2.2 Furnishing products burning behaviour

5.2.2.1 Full scale test in the furniture calorimeter

5.2.2.1.1 General

The modified furniture calorimeter for upholstery furniture burning behaviour is described in Annex B.

5.2.2.1.2 Determination of extent of vandalism

The seat composite shall either be tested in a fully vandalised condition (Figure B.8) or shall be subjected to a standard vandalism test. The level of vandalism achieved in the test described in Annex A shall be reproduced on the real seat before the real scale test described in Annex B.

5.2.2.1.3 Special test conditions

Reclining seats shall be tested in the most upright position.

Tip up seat requirements:

a) tip up seats staying in the down position, when not occupied:

   This type shall be tested as a normal seat;

b) tip up seats returning automatically to the up position when not occupied:

   This type shall be tested as a normal seat and shall have a design requirement for the fire protection given by the seat shell. This requirement shall be that the shell protects any bottom edges of the seat trim, when in the up position.

5.2.2.2 Fire integrity testing of the assembled products from rear side

There is a general requirement (F1C and F1D in Table 2) to test the full seat composite, (shell and upholstery) from the rear side.

If the material/composite forming the surface passes, (in addition to all other relevant requirements), the integrity condition described in 5.3.6, there is no requirement to test the whole composite.

This test is applicable for:

a) the base shell and the back shell of passenger seats;

b) the downward and vertical facing surface of armrests;

c) the downward facing surface of couchettes and beds.

5.3 Testing rules

5.3.1 Products or assemblies

5.3.1.1 General

These shall be tested at their full thickness. If the full thickness is greater than the maximum thickness that can be tested in the applicable standard, then the thickness shall be reduced by cutting away the excess part from the rear face of the sample; that is from the face that is not exposed to the ignition source.

The exposed surface of the test specimen shall be the same as in the end use condition.

The test house shall report the condition of the edges of all test specimens to assist in evaluation of the validity of the certification in the context of the end use condition.

5.3.1.2 Assembled products and surfaces to be tested

Exposed surfaces of a material which form part of an assembly shall be tested to the appropriate requirement set defined in Table 2.

Any material that is part of an assembly, but does not form part of all fire test pieces, for example because it exceeds the thickness limit of the test methods, shall be separately tested to the relevant requirement(s) as defined in R17. This requirement is not applicable to seat upholstery assemblies (because seat assemblies are tested according to R18 and R21).

5.3.2 Hoses or Pipes

In cases where it is not possible to produce test plaques with the required dimensions, the test piece shall be produced from longitudinal sections, produced by splitting the hoses or pipes, placed in touching contact. The sections shall be placed so that the convex surface is towards the source of heat at a distance approximately equal to the thickness of the hose wall or pipe wall.

5.3.3 Substrates for surface products

5.3.3.1 General

A list of standard substrates is given in Table 7 as described in 4.2d).

The steel sheet represents the standard substrate for all steel substrates.

The aluminium sheet represents the standard substrate for all aluminium substrates.

Table 7 — Standard substrates for surface products (EN 13238)

Nature	Nominal density [kg/m^3]	Thickness [mm]
Steel sheet	7 850 $\pm$ 50	0,8 $\pm$ 0,1
Aluminium sheet	2 700 + 50	1,0 $\pm$ 0,2

5.3.3.2 Rules for preparation of test specimens

Specimens shall be prepared to reproduce the products in their end-use condition. This shall include where used, but is not limited to:

a) the type and quantity of adhesive;

b) any mechanical fixings;

c) production parameters such as surface preparation, pressures, temperatures and timings.

If different methods of attachment are used in practice, a choice may be made, in agreement with the test house, to take into account the worst case (which shall be stated in the test report). If this cannot be agreed, each different fixing method shall be tested.

If mastic materials cannot be tested in end-use condition, a thickness of 3 mm of the mastic material prior to curing shall be applied to a non combustible support.

NOTE This is because of the non-specific use of mastic materials.

5.3.4 Test specimen preparation for upholstery products

The test specimen preparation methods for:

a) cone calorimeter method according to ISO 5660-1; and

b) smoke and toxicity testing;

are described in Annex D.

5.3.5 Linear cable containment products

The requirements for linear cable containment products depend on their location (interior/exterior), the shape of their cross section and their perimeter. The requirements are shown in Table 8 for circular conduits and in Table 9 for rectangular ducts.

Test specimens shall be obtained from the end product. Both the cover and base require testing if they are of different thickness.

To prepare a full size test specimen where the product is not continuous (e. g. contains holes, slots, profiles), this shall be done by cutting pieces from the product, and placing them together to make a continuous test piece.

For circular conduits test pieces shall be prepared in accordance with the guidance for hoses in 5.3.2.

Parameters

P = perimeter in m

L = length as installed in m

S = largest side m

Table 8 — Circular conduit

Perimeter	Requirement interior	Requirement Exterior
$0,0 < P \leq 0,2$	R22	R23
$0,2 \leq P$	R6	R9

Table 9 — Rectangular duct

Condition		Perimeter/ Largest Side	Requirement interior	Requirement Exterior
P x L > 1	and	$0,2 \leq S$	R1	R7
P x $L \leq 1$	and	$0,2 \leq S$	R6	R17
P x L > 1	and	$0,12 < S < 0,2$	R6	R9
P x $L \leq 1$	and	$0,12 < S < 0,2$	R6	R23
		$0,0 < S \leq 0,12$	R22	R23

NOTE All general requirements for technical cabinets apply - see 4.2.

5.3.6 Fire integrity testing

After the cone calorimeter test according to ISO 5660-1 (T03.01 and T03.02), the test piece shall be allowed to cool and then shall be carefully lifted using only the edges of the test piece, keeping the test piece horizontal.

There shall not be more than one hole. This hole shall have no dimension in the plane of the test piece greater than 3 mm.

Alternatively, if the material fulfils the requirements of Conventional Classified Products according to EN 45545-3, the product is considered to meet the integrity requirements.

5.3.7 Assessment for burning droplets / particles

Only droplets/particles that exhibit sustained flaming (ref. ISO 5658-2:2006, Clause 11 and Clause 13) shall be reported. Sustained flaming is to be interpreted as flaming for more than 10 s on a clean calcium silicate board positioned on the floor beneath the test specimen.

a) any obstructions to flow/falling of the droplets/particles onto the floor (such as steel plates or framework bars below the test specimen) shall be removed from the test apparatus.

b) the specification of the calcium silicate board shall be the same as that for calcium silicate substrate boards in EN 13238.

c) the distance from the midpoint on the test specimen to the floor shall be 1 200 mm $\pm$ 100 mm.

6 Evaluation of conformity

See EN 45545-1.

Annex A
(normative)

Standard vandalism test for seat coverings

A.1 Introduction

This test determines the ability of the seat to resist vandalism with a blade prior to an arson attempt. The test shall be performed by the fire laboratory before the fire test for vandalised seating (Annex B) to determine the extent of vandalism that shall be reproduced on the fire test specimens.

A.2 Apparatus

Set up the apparatus so that the following forces as specified in Figure A.1 are obtained:

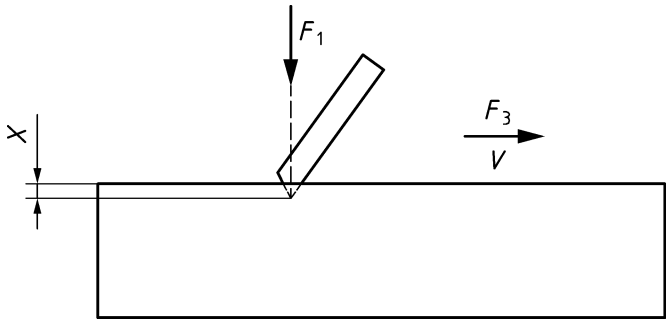
a) the force F1 of the blade shall apply to the test specimen with a pressure of (150 ± 5) N and with a potential penetration of 20 mm. The pressure measurement shall be calibrated using a balance with a precision of 5 g;

b) the force of traction F3 of the blade shall be (150 ± 5) N, for all the duration of the traction path. The force measurement shall be calibrated with a weight of 15 kg applied to the undercarriage;

c) the blade advance system shall be adjusted so that the blade moves with a speed v of (60 ± 5) mm/s;

d) the tension of the covering on the foam shall be regulated with a dynamometric wrench set to a force F2 of (50 ± 3) N.

NOTE The apparatus may be constructed in any appropriate way provided that the above performance requirements are maintained.



Key

F1 (150 ± 5) N

F3 (150 ± 5) N

x up to 20 mm

v (60 ± 5) mm/s

Figure A.1 — Schematic system of forces on blade

A.3 Preparation of test specimen

A representative sample is obtained from the seat having dimensions of 300 mm × 450 mm, in full thickness if the thickness of the seat is less than 50 mm, or 50 mm thick if the thickness of the seat is greater than 50 mm. The edges of the test specimen shall be completely covered by the seat covering.

When there are two different fabric directions, the test shall be carried out in both orientations. Specimens shall be conditioned at a temperature of 23 °C ± 2 °C, RH 50 % ± 5 % until constant mass (according to EN 13238).

A.4 Test procedure

A.4.1 Number of tests

Three replicate tests shall be carried out.

A.4.2 Setting up the apparatus

a) Ensure that the trolley slides regularly and easily on the two guides parallel to the frame;

b) fix the blade on the blade holder;

c) check the force F1 on the blade with a balance;

d) check the force F3 with a weight and the time of laceration;

e) adjust the tip of the blade so that it will penetrate to a depth of 20 mm when a test specimen is in place (Figure A.1).

A.4.3 Preparing and fitting of the test specimen

a) Prepare the test specimen with the foam and the coverings (fabric and interliner, if required);

b) fix the coverings along the complete length of one edge and pull them over the foam until they are uniformly tensioned (force F2); then, fix the coverings along the complete length of the second edge;

c) the blade tip shall be located at 30 mm from the edge of the specimen;

d) a new blade shall be used for each test (Figure A.2).

A.4.4 Penetration and laceration tests

The penetration test involves applying a vertical force F1 onto the lever to allow the tip of the blade to penetrate the seat covering. The lever shall be kept in this position by the blocking system.

The laceration test consists in applying a traction force onto the trolley by means of the traction device and a speed of traction of (60 ± 5) mm/s. The duration of the test shall be (5 ± 1) s.

A.5 Results

Remove the specimen from the vandalism test apparatus and put the specimen on a flat surface. Report the layers (textile, under layer, foam) that have been fully cut through to more than 50 mm laterally. A cut of less than 50 mm is considered as non-vandalised according to the requirements for the preparation of the test specimen described in B.4.3.

A.6 Test report

The test report of the vandalism test shall report at least the following data:

a) penetration force [N];

b) penetration depth [mm];

c) traction force [N];

d) covering tension [N];

e) length of the laceration [mm];

f) photographs of the laceration.

Dimensions in millimetres

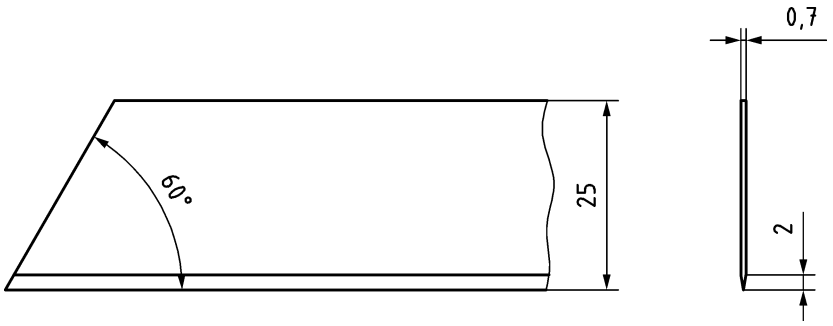


Figure A.2 — Specification of the blade

Material: thin carbon – chrome steel HSS: ISO 11054.

Hardness / 800 HV5: EN ISO 6507-3.

Annex B
(normative)

Fire test method for seating

B.1 General

This protocol provides a means of determining the burning behaviour of seating intended for use in railway applications by measuring specific fire test responses when the test specimen, which may be a complete passenger seat (including arm and head rest, separate pillow, tip up seat or a driver seat accessible to the passenger) is subjected to a specified flaming ignition source under well-ventilated conditions. This protocol does not provide information on the fire performance of seats under conditions other than those specified in this test protocol.

The rates of heat emission from a burning test specimen determined in kW shall be measured by oxygen consumption calorimetry. From these data, the $MARHE$ value shall be calculated.

B.2 Safety warning

The attention of all persons concerned with managing and carrying out the tests described in this standard is drawn to the fact that fire testing can be hazardous and that toxic and/or harmful smoke and gases can be produced during the test.

An assessment of all potential hazards and risks to health should be made and safety precautions should be identified and provided. Smoke and gases should be removed from the workplace. Written safety instructions should be issued. Appropriate training should be given to relevant personnel. Laboratory personnel should ensure that they follow written safety instructions at all times.

Special precautions are required for the propane gas supply system:

a) the equipment, for example tubes, couplings, flow meters, should be approved for propane.

b) there should be an automatic cut off of the gas supply in case of extinction of the burner flame or the apparatus should be monitored by a person as long as it operates.

Special precautions are required for the extinction of burning specimens:

c) when extinguishment is carried out because of intensive combustion of the test specimen, it is recommended that a second operator is ready to intervene. Means for extinguishing should be available (e. g. since the heat output during intensive combustion can damage the apparatus).

B.3 Test facility

B.3.1 Hood and smoke exhaust system

The hood and the exhaust system of the test apparatus is similar to the furniture calorimeter described in the ISO/TR 9705-2, shown in Figure B.1. The dimensions are given in ISO 9705, Figure D.2.

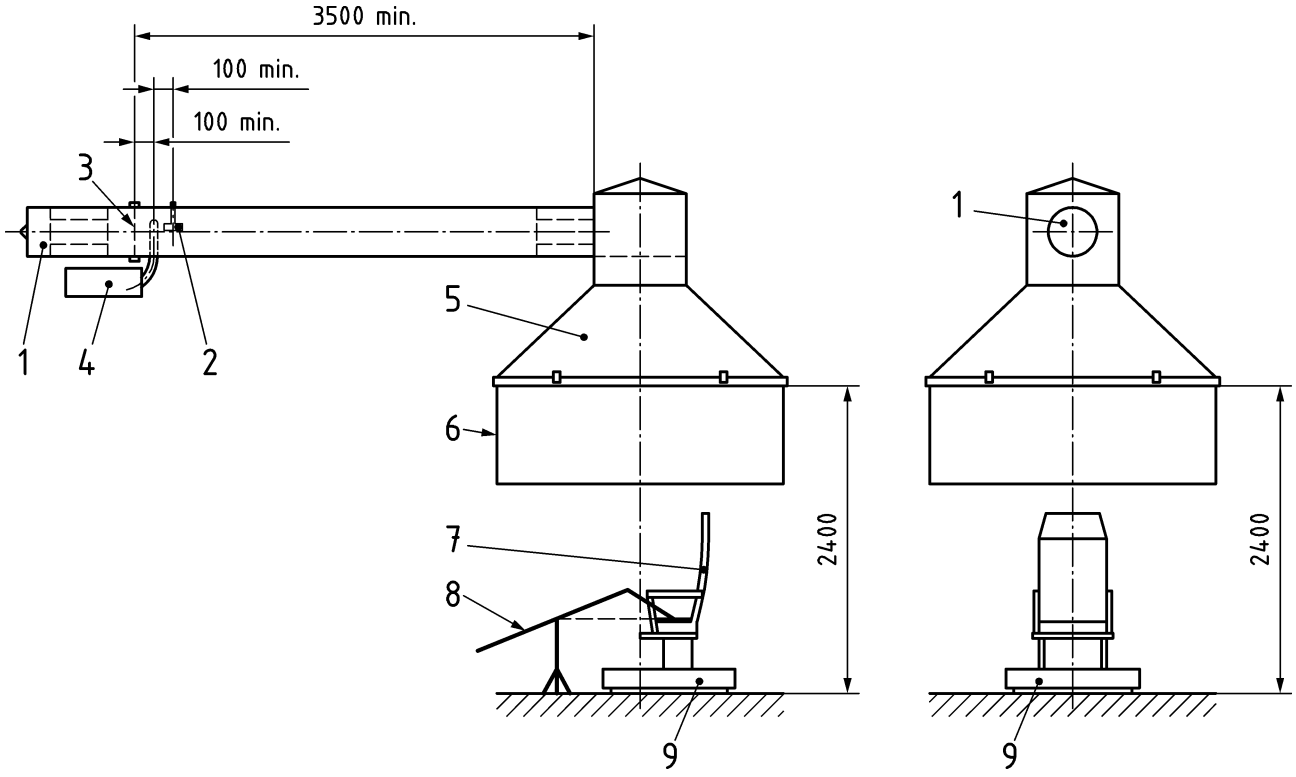
A general scheme of the test method and measurement system is described in Figure B.1.

NOTE 1 Due to changes in heat output, some exhaust systems (especially those provided with local fans) can need manual or automatic readjustment during tests, to meet the requirement of the given volume flow.

NOTE 2 The duct should be cleaned at intervals to avoid excessive accumulation of soot.

The volume flow should be measured with a Pitot Tube or a Bi-directional probe, connected to a pressure transducer with a range of at least 0 Pa to 250 Pa, and a precision of ± 2,5 Pa. The pressure transducer output shall have a 90 % response time of 1 s or better.

Dimensions in millimetres



a) Front view **b) Side view**

Key

1 exhaust duct d = 400 mm
2 pitot tube
3 lamp, photocell system
4 gas analysis (0_2, CO, CO_2)
5 ISO 9705 Hood
6 steel plates 1 000 mm × 3 000 mm
7 seat product
8 burner
9 balance

NOTE For the purpose of this document, the photocell is not used.

Figure B.1 — Furniture calorimeter test method (schematic) for furniture used in railway vehicles

The gas sampling probe shall be connected to a gas conditioning unit and gas analysers for O_2 and CO_2.

a) The O_2 analyser shall be of the paramagnetic type and capable of measuring at least in the range of 16 % to 21 % oxygen (V_{02}/V_{air}). The response time of the analyser shall be not more than 12 s. The noise and drift of the analyser shall be not more than 100×10^{-6} (100 ppm) over a period of 30 min. The output from the analyser to the data acquisition system shall have a resolution of maximum 100×10^{-6} (100 ppm).

b) The CO_2 analyser shall be of the IR type and capable of measuring at least a range of 0 % to 10 % carbon dioxide. The linearity of the analyser shall be 1 % of full scale or better. The response time of the

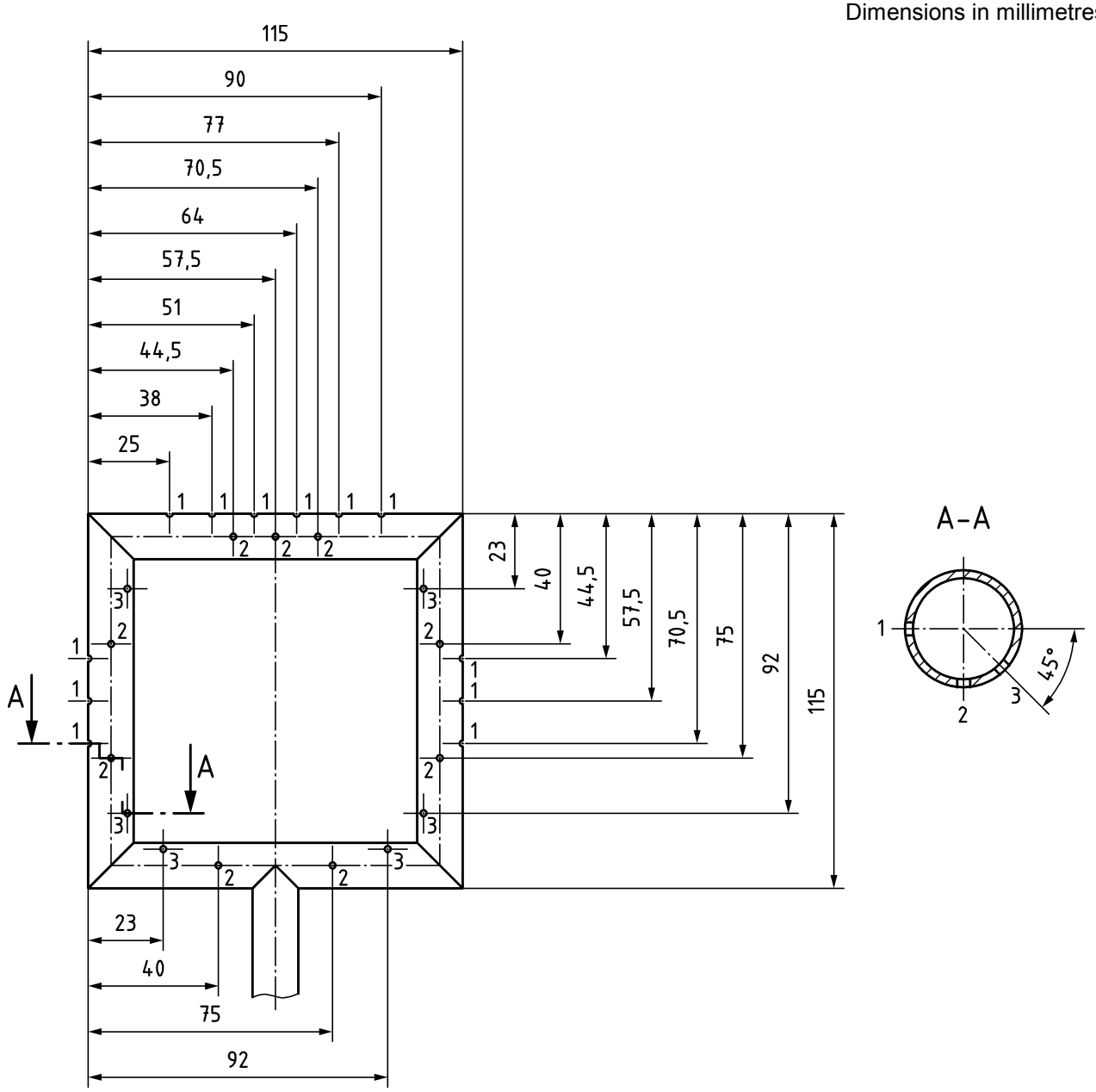
analyser shall be not more than 12 s. The output from the analyser to the data acquisition system shall have a resolution of not greater than 100×10^{-6} (100 ppm).

B.3.2 Ignition source “EN 45545 square burner”

The burner described in Figure B.2 to Figure B.4 is made of a stainless tube with external diameter (14,0 ± 0,1) mm – internal diameter (9,0 ± 0,1) mm, ending in a square part of (115 × 115) mm side, angled at 35° relative to the tube.

In this square part a series of 27 holes with a diameter of 1,2 mm are drilled with different orientations, as shown in Figure B.2. A special spacer, attached by screws to the burner's terminal part, maintains the distance of 10 mm between the underside of the burner and the spacer's contact point with the burning surface of the test assembly seat during the test.

Dimensions in millimetres



Key

1 horizontal, parallel to the seat

2 vertical, perpendicular in direction to the seat

3 with inclination of 45° to the inside

Figure B.2 — Position of the holes

The overall length of the burner is about 1 500 mm. The burner is included in an oscillating system which, by mean of a sliding counterweight, allows to load the burner itself so to apply to the test assembly a pressure corresponding to that given by the represented ignition source. The burner is connected to a gas cylinder (or tank) containing liquefied propane (purity 99 %) through a flexible tube, a mass flow controller with a suitable fine control valve and stop valve. The precision of the mass flow controller shall be better than ± 10 mgs^{-1} at a propane mass flow rate of (151 ± 5 mgs^{-1}) (the rate used during the tests).

The flexible tube connecting the outlet of the flow rate measuring device to the burner tube shall have a length between 2,5 m and 3,0 m and an internal diameter of (7 ± 1) mm.

The spacer consists of a stainless steel flat bar, 1,5 mm thick and 17 mm wide, placed across the burner's square terminal part and profiled so to protrude for 10 mm from its underside (see Figure B.3).

Dimensions in millimetres

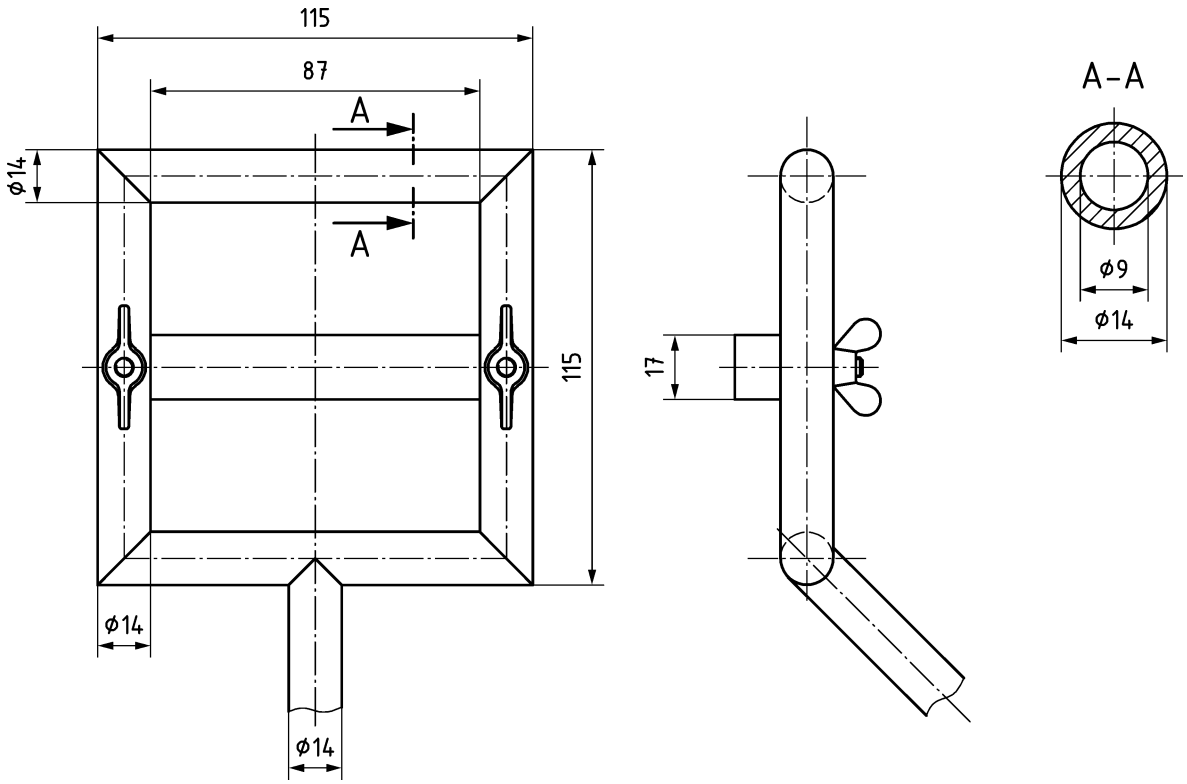


Figure B.3 — Position of the spacer

Dimensions in millimetres

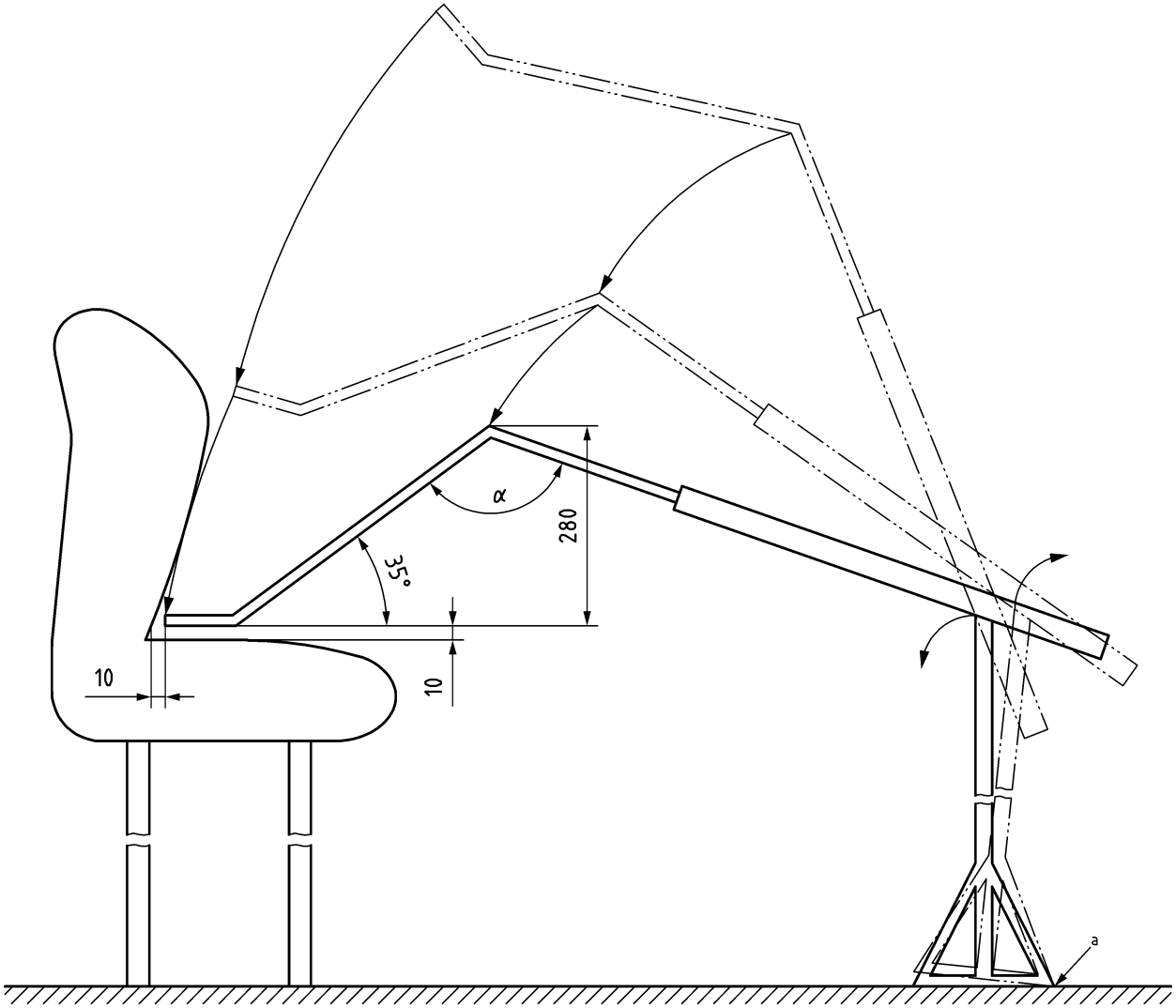
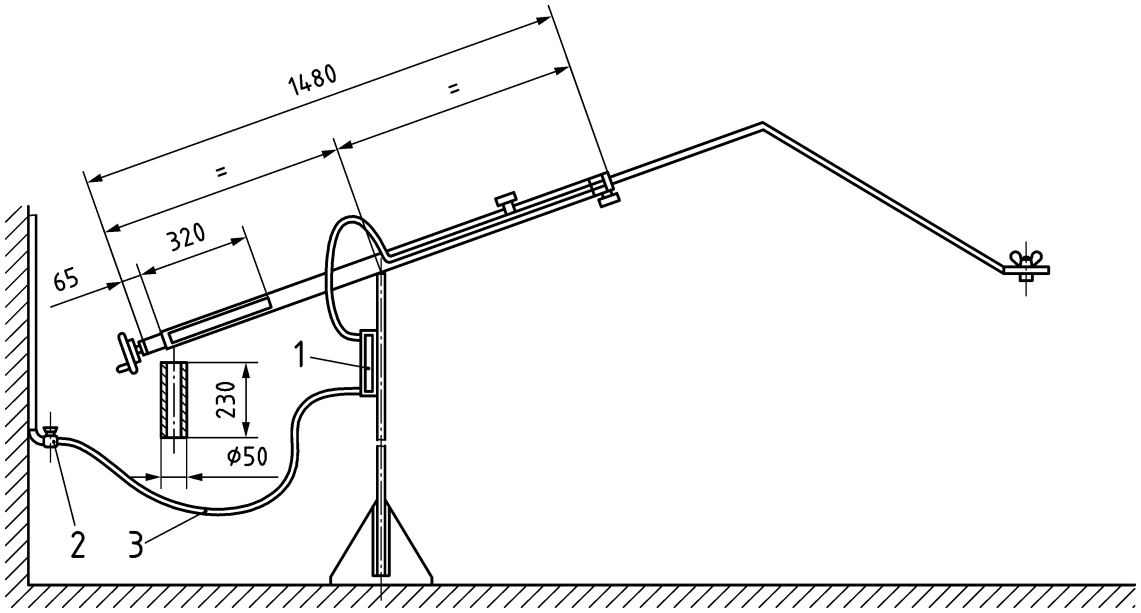


Figure B.4 — Position of the burner on the seat

If the shape of the back does not allow the burner to descend without interruption then the whole burner assembly shall be moved back to avoid the descent being interrupted. The final position of the burner shall be adjusted to give the standard position (10 mm between the backrest and the end of the burner).

Dimensions in millimetres



Key

1 rota meter

2 gas valve

3 gas tube

Figure B.5 — Front view of the counterweight (without burner)

Dimensions in millimetres

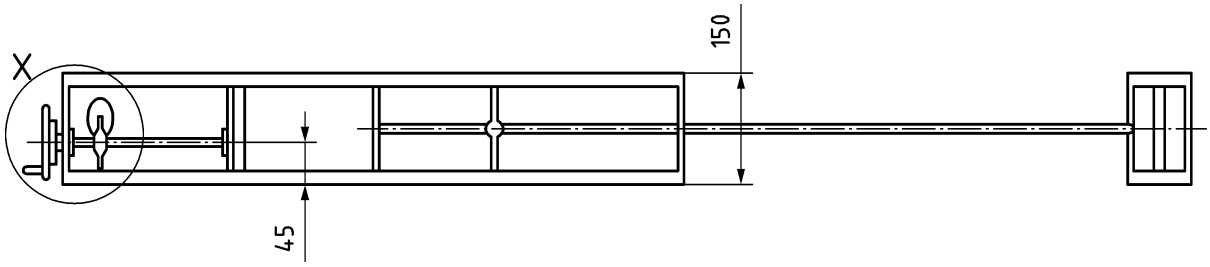


Figure B.6 — Plan view of the counterweight

Dimensions in millimetres

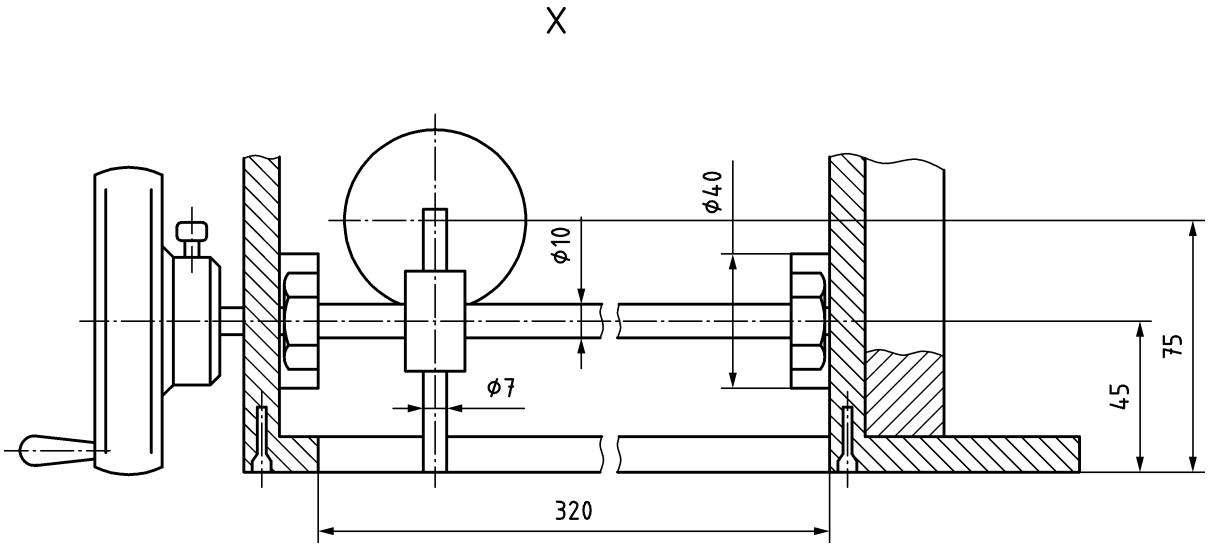


Figure B.7 — Detail A of the counterweight

B.3.3 Other general equipment

a) A thermocouple, of the K-type in accordance with EN 60584-1, diameter (1 ± 0,5) mm for measuring the ambient temperature of the air flow into the test room and the temperature of the air flow into the duct.

b) Equipment for measuring the ambient pressure, having a precision of ± 200 Pa (2 mbar).

c) Equipment for measuring the relative ambient air humidity, having a precision of ± 5 % within the range 20 % to 80 %.

d) A data acquisition system (used to record the data automatically) having a precision equal to or better than 100×10^{-6} (100 ppm (0,01 %)) for O_2 and CO_2 , 0,5 °C for the temperature measurements, 0,01 % of full scale instrument output for all other instruments and 0,1 s for time. The data acquisition system shall record and store the following quantities every 3 s:

1) time, in s;

2) mass flow of propane gas through the burner, in mgs^{-1};

3) pressure difference from the bi-directional probe, in Pa;

4) O_2 volume fraction, in (V_{02}/V_{air}) %;

5) CO_2 volume fraction, in (V_{02}/V_{air}) %;

6) ambient temperature, in K.

B.4 Test specimens

B.4.1 General

Full passenger seats representative of production supply, appropriately vandalised, shall be tested. The seats shall include arm and head rests, back and base shell.

B.4.2 Number of tests

Three tests shall be carried out.

B.4.3 Preparation of the test specimen

The level of vandalism determined during the test of Annex A shall be reproduced in the following way.

The layers that were cut or perforated for a longer distance than 50 mm shall be cut along the diagonals beginning 50 mm from the corners (as shown in Figure B.8). The fully cut layers shall be rolled up and pinned as shown in Figure B.8. The rolling and pinning shall be done so that there is no interference with the burner trajectory.

To make sure that the requirements of the burner position are fulfilled, the rolled up flaps at the interface between the back and base of the seat shall be cut off.

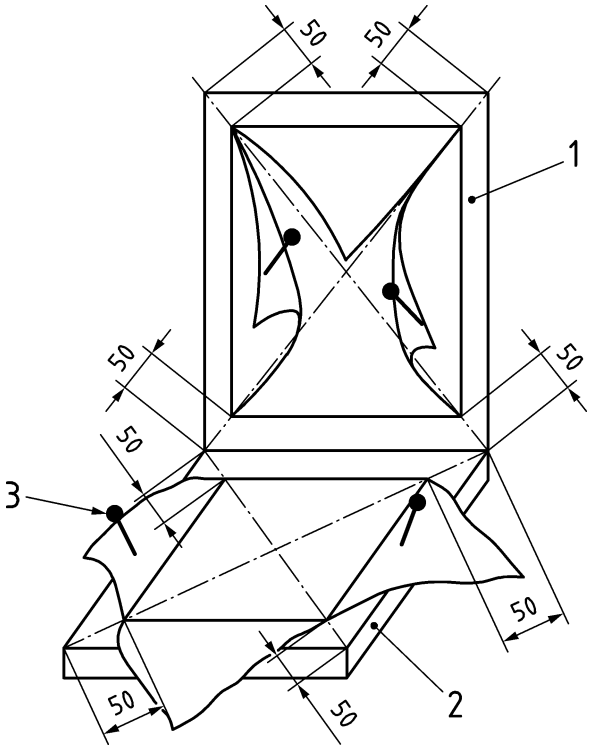
If one of the fully cut through layers is bonded to an underlayer, when the bonded layer is lifted and turned back there are several possible occurrences:

— when pulling the bonded layer back it remains integral (e. g. woven glass layer bonded to a core foam) and brings with it some additional material from the underlying layer. In this circumstance the underlying material that comes away during the process is left bonded to the pulled back layer;

— when pulling the bonded layer back it tears easily within itself (e. g. a weak felt bonded to a core foam) no underlying material is lifted with it and it is not possible to remove any significant area of the layer in a single action. In this circumstance the (weak) layer shall be lifted / scraped away until only well bonded material remains;

— if it is not possible to pull back the damaged layer(s) away from the upholstery foam, leave the surface layer(s) as cut in the vandalism test.

Dimensions in millimetres



Key

1 vandalised backrest

2 vandalised base shell

3 pinned layer

Figure B.8 — Specimen preparation with fully cut layers

B.4.4 Conditioning of test specimen

The conditioning shall be in accordance with EN 13238 and the requirements of 4.2.

The entire testing procedure until the end of the test shall be carried out within 2 h of removal of the specimen from the conditioning environment.

B.5 Test procedure and application of the burner

Perform the following steps in sequence, with the measuring equipment operating and with the test specimen and the burner placed under the hood.

The burner shall be supported on an arm which can pivot in a vertical plane such that the plane of movement of the burner shall coincide with the vertical plane of the (front to back) centre line of the seat. When swung into the test position on the seat the leading edge of the burner shall be 10 mm from the surface of the seat back and the face of the burner shall be spaced off from the surface of the seat base by 10 mm, by use of a flat bar on which the burner rests (see Figure B.3).

Set the volume flow of the exhaust, V_{298} to $(0{,}6 \pm 0{,}05)$ m^3/s. This volume flow shall be within the range 0,5 m^3/s to 0,7 m^3/s during the total test period.

NOTE 1 Due to changes in heat output, some exhaust systems (especially those provided with local fans) can need manual or automatic readjustment during the test, to meet the requirement of volume flow given.

When in position, the burner shall have an effective mass resting on the seat of 100 g. This effective mass shall be achieved by the use of a counterweight on the pivoting arm (see Figure B.5).

NOTE 2 To measure the effective mass resting on the seat of 100 g it is suitable to place the whole test specimen onto a scale with a precision of equal or better than 2 g.

At the start of the test the burner shall be raised clear of the seat such that a line mutually perpendicular to the base of the burner and projecting from its centre, is at least 200 mm above the top of the seat back when measured in a vertical plane which includes the top of the seat back.

Record the pre-test conditions; ambient pressure (Pa) and ambient relative humidity (% H_2O).

Record the temperatures of the thermocouples in the exhaust duct and the ambient temperature for at least 60 s. The ambient temperature shall be within (20 $\pm$ 10) °C and the temperatures in the duct shall not differ more than 4 °C from the ambient temperature.

Start the time measurement with the chronometer and the automatic recording of data. The time of start is t = 0 s. The following data shall be measured and recorded automatically every second during the whole test period and shall be stored for further processing:

— the time (t) in s;

— the mass flow rate of propane gas to the burner (m_{gas}) in mgs^{-1};

— the pressure difference between the two chambers of the Bi-Directional Probe (Δp) or the Pitot tube, at the general measuring section in the exhaust duct, in Pa;

— the O_2 mole fraction in the exhaust flow (xO_2), sampled at the gas-sampling probe in the general measuring section in the exhaust duct.

NOTE 3 The oxygen and carbon dioxide concentrations are measured only in the exhaust duct; both concentrations are assumed to be constant in the air that enters the test room. It should be noted that the air supplied from a space where oxygen is consumed (e.g. by fire tests) cannot fulfil this assumption.

— the CO_2 mole fraction in the exhaust flow (xCO_2), sampled at the gas-sampling probe in the general measuring section in the exhaust duct:

— the ambient temperature (T_0), in K;

— the temperature in the exhaust duct (T_E), in K.

At t = (60 $\pm$ 3) s: ignite the burner in the neutral position and adjust the propane mass flow. The flow of propane shall be 151 mgs^{-1} ± 5 mgs^{-1} (equivalent to 4,6 dm^3 ± 0,2 dm^3 per min) generating a power of 7 kW ± 1 kW. The adjustments shall be made before t = 90 s. The mass flow shall be within this range during the total test period.

NOTE 4 The time period 90 s < t < 120 s is used to measure the base line for the heat release rate (HRR). The HRR should be (7 ± 2) kW.

At t = (120 $\pm$ 3) s: swing the burner into place as specified above. The period 0 s to 120 s is known as the "Stabilisation Period" and times during this period are known as "Stabilisation Period" times.

At t = (300 $\pm$ 3) s: After a further period of 180 s the burner shall be lifted to the neutral position and extinguished by removing the gas flow within 15 s. Data recording shall continue for a further 1 200 s (1 500 s in total).

The period 120 s to 1 500 s is known as the "test period" and for the purposes of simplicity in the calculation of requirements; times in this period are known as "test period" times and are rescaled by 120 s thus removing the times used in the Stabilisation Period. Thus, for the full time-line, stabilisation period time 120 s is test period time 0 s. The test period therefore lasts for 1 380 s.

NOTE 5 The nominal exposure period of the specimen to the flames of the burner is 180 s. The performance is evaluated over a period of 1 380 s.

Observe the burning behaviour of the specimen for the ”test period”.

At $t \geq 1\,500$ s: stop the automatic recording of data.

B.6 Early termination of test

The test may be stopped earlier than the nominal test period if any of the following conditions occur:

a) a heat release rate of the specimen exceeding 350 kW at any instant, or exceeding a mean value of 280 kW over a period of 30 s;

b) an exhaust duct temperature exceeding 400 °C at any instant, or exceeding a mean value of 300 °C over a period of 30 s.

If there is an early termination of the test, record the time of termination of the test and the reason why. The results of a test are not valid for classification purposes when an early termination of the test has occurred.

NOTE Measured values for the temperature and the heat release rate will contain a certain amount of noise. It is therefore advised not to stop the test on the basis of only one or two successive measurement values from the instruments exceeding the given maxima.

B.7 Test results

The calculations should be done in accordance with ISO 9705. As a minimum, O_2 and CO_2 should be used for the calculation of HRR.

The expression of results should be done for each test. The burning behaviour of the seats shall be represented by graphs of heat release rate versus time, and $MAHRE$ versus time, which shall be produced for the "test period" for each test.

In addition, one photo of an untested seat and a photo of each tested seat after the end of the test should be taken. Additional photos during the test period are recommended.

The $MARHE$ parameter shall be derived on the basis of "test period" times. The $MARHE$ requirements given include the heat output from the burner during the Test Period. The first data point is therefore (7 kW, 0 s).

For the purpose of classification the average of the $MARHE$ values from the 3 tests shall be calculated.

B.8 Test report

The test report shall include the following information:

a) a statement that either; i) the test was carried out in accordance with this standard or ii) the test was carried out with deviations from this standard, in which case the deviations shall be stated together with the reasons for the deviations;

b) the name and address of the testing laboratory;

c) the date and identification number of the report;

d) the name and address of the sponsor;

e) the name and address of the manufacturer / supplier, if known;

f) the date of sample arrival;

g) an identification with description of the product, preferably with drawings where appropriate;

h) a description of the sampling procedure, where relevant;

i) a general description of the seats tested including a photograph of an untested seat;

j) details of conditioning;

k) the date of test;

l) the test results;

m) the photographs of the tested seats;

n) observations made during the test;

o) the following statement: "The test results relate to the behaviour of the test specimens under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use".

Annex C
(normative)

Testing methods for determination of toxic gases from railway products

C.1 Introduction

For assessment of toxic gases from railway products the Conventional Toxicity Index (CIT) is used which is calculated from test data. The CIT parameter has a specific meaning for specific materials/products, but in all cases it is comprised of two terms:

CIT = [Precursor Term] × [Summation Term]

The Summation Term is produced from the ratios of the emission level to the reference level of the gas component.

If the emission level and reference level do not have the same dimensions, then the Precursor Term has dimensions so as to cancel the dimensions of the Summation Term: CIT is always dimensionless.

Details of the derivation of CIT_G (for general products) and CIT_{NLP} (for non-listed products) are specified in C.16.

NOTE 1 Details of the derivation of CIT for cables are specified in EN 50305.

For the scope of this document, the following 8 gas components need to be analysed: CO_2; CO; HF; HCl; HBr; HCN; SO_2; NO_x.

The reference concentrations are given in Table C.1.

NOTE 2 NO_x includes both NO_2 and NO quoted as NO_2.

Table C.1 — Reference concentrations of the gas components

Gas component	Reference concentration [mg/m^3]
CO_2	72 000
CO	1 380
HBr	99
HCl	75
HCN	55
HF	25
NO_x	38
SO_2	262

NOTE 3 These reference values are based on IDLH (Immediately Dangerous to Life and Health), recognised as a limit for personal exposure to the gas component by NIOSH (National Institute for Occupational Safety and Health) (1997 version).

There are two methods detailed in this document that shall be used for determining the composition of gases and fumes generated by the combustion of specified railway products. These methods are described as follows:

Method 1: Smoke Chamber

This method is based on the exposure of a specified surface area for the test specimen. In this context, the test procedure is consistent with the methodology for measuring the smoke density of railway products. The test apparatus and conditions for Method 1 are described in EN ISO 5659-2 with additional gas analysis information provided in this document.

Method 2: Tube Furnace

This method is based on the exposure of a small mass of test specimen (1 g). The test apparatus and conditions for Method 2 are described in NF X70-100-2 with additional gas analysis information provided in this document.

When the CIT for a product on a railway vehicle is required, only one method shall be used for the testing, gas analysis and calculation of CIT. The method to be used is shown in Table C.2.

Table C.2 — Test method to be used for determination of Conventional Index of Toxicity (CIT)

Product	Method 1 EN ISO 5659-2 Smoke chamber Area-based test	Method 2 NF X70-100-2 Small mass-based test
Products with large areas or significant surface areas; e. g. interior walls, floor coverings, seat backs and coverings	Yes	No
Non-listed products; e. g. minor mechanical components	No	Yes

The test conditions specified for use when performing test Method 1 and Method 2 depend upon the application and position of the product on the railway vehicle. The conditions selected are representative of fires that may impact on the railway product during either the developing stages or the developed stage of a fire inside or outside the railway vehicle.

The exposure conditions of the test specimen in the smoke chamber are radiant heat with or without application of a pilot flame. For large area products such as walls and ceilings, the test specimens shall be exposed to radiant heat flux conditions that simulate a developed stage of a fire; that is a heat flux of 50 kW/m^2 without a pilot flame. For floor coverings that generally receive lower levels of radiant heat during a fire, the test specimens shall be exposed to a radiant heat flux of 25 kW/m^2 with a pilot flame.

The exposure conditions of the test specimen in the tube furnace are generally set at one furnace temperature and one ventilation condition. Railway products specified in this document shall be tested in the tube furnace at 600 °C, which represents a developing fire condition.

In Method 1, the first gas samples shall be taken so as to allow values at time t_1 equal to 240 s to be determined. The second gas samples shall be taken so as to allow values at time t_2 equal to 480 s to be determined.

The condition that gives the highest value of CIT (mean of 3 test specimens) for either t_1 or t_2 sampling time shall be used for the purpose of requirements. In Method 2, the mean CIT result of 3 test specimens shall be used for the purpose of requirements.

NOTE Continuous sampling and analysis of fire gases should provide more realistic assessment of the potential toxicity of effluents from fires involving railway products. At present, the experimental procedures for analysing these effluents and the calculation methods required to assess their incapacitating and lethal effects on passengers and staff are still being developed.

C.2 Method 1 – Test apparatus

C.2.1 General

The test equipment shall consist of a smoke chamber as described in EN ISO 5659-2 and an FTIR sampling system. The FTIR sampling system shall be assembled and operated according to the instructions of the manufacturer.

The two measuring sections of the equipment, dedicated respectively to the analysis of the opacity of the smoke and to the qualitative and quantitative analysis of gases emitted during the test, shall be capable of operating at the same time. The two sections of the equipment, however, can operate independently using two specific procedures for the acquisition of data ($FTIR$ spectra and smoke opacity). The necessary calculations for the determination of the parameters are described in the reference standards and in C.6 and C.16.

C.2.2 Calibration of the radiating cone

The calibration of the radiating cone shall be in accordance with EN ISO 5659-2.

C.2.3 Smoke chamber – Smoke density

The smoke opacity during the combustion of the material shall be determined measuring the attenuation of a white light beam by the effluents. The obscuration produced from the smoke is measured as a fraction of the light intensity reaching the photometric detector in the presence of smoke to the value corresponding to the luminous transmission in the absence of smoke before the start of the test.

C.3 Analysis of fire effluents for Method 1

C.3.1 Principles of *FTIR* gas analysis used in a discontinuous way

The method consists of a sampling procedure and analysis of gases present in the fire effluents by the discontinuous way using spectroscopy in the Fourier transform infrared technique ($FTIR$). The $FTIR$ technique is used for the identification and the quantification of compounds constituted from diatomic and polyatomic molecules with heteronuclear linkages. The apparatus shall be able:

a) to direct a luminous beam through the cell of analysis and to collect an interferogram at a pre-established time that corresponds to either 240 s or 480 s from the beginning of the test;

b) to convert these into absorption spectra and to analyse them subsequently;

c) to calculate the concentrations of gases present in the sample by evaluation of the quantity absorbed (by area or by height) in the characteristic band of absorption of the compound, in comparison with the spectra obtained with reference gas mixtures at known concentrations.

The analysis of the spectrum collected during the test determines the concentration of gases. The analysis shall be done using the equipment and the procedures for testing and calibration described in ISO 19702 and detailed in the following paragraphs.

C.3.2 Probe for sampling of effluents

A sample of the fire atmosphere shall be drawn out from the chamber at a prefixed position. The sample of effluent, which is preliminarily filtered, is extracted in a discontinuous way at *240 s and 480 s* into the test by a probe into the gas cell for the analysis by absorption of infrared beams within the FTIR spectrometer. The inner sampling method shall be performed with a stainless steel probe (5 mm inner diameter) that is vertically inserted from the centre of the ceiling inside the smoke chamber. The sampling probe shall be placed at 300 mm under the ceiling of the chamber (see Figure C.1). The thermocouple shall be placed at a maximum distance of 5 mm from the end of the probe. The temperature shall be recorded when the sampling has been made in order to calculate the mass concentration of gas species.

After the valve (Key 9 in Figure C.1) a *PTFE* soot-filter shall be used. A cylindrical or planar membrane filter with porosity of 3 microns or less should be used to preserve the cell internal mirrors. The filter unit shall be such that the filter element can be changed easily. The filter shall be suitable for use at temperatures of 165 °C ± 15 °C for a long period.

NOTE 1 The filter should be heated to (165 ± 15) °C in order to prevent water-soluble gases from dissolving in condensed water. A *PTFE* filter is specified because it is not sensitive to any of the 8 gases being quantified.

A flow rate of 4 l/min ± 0,5 l/min shall be used for sampling in order to avoid an under pressure condition of the chamber and any interference on the continuous smoke density measurement when the gases are sampled.

NOTE 2 The sampling time for each of the 2 points is approximately 30 s, so the total volume drawn out for both the analyses is about 4 l and this is useful in that it partially compensates the overpressure caused by the burning of the test specimen.

The flow rate should be used in accordance with cell volume and optical path length in order to collect a spectrum within 15 s or less. The response time (time needed to replace totally the gas in the cell) should never exceed the time for spectrum collecting. The delay time (time for the gas circulation from the probe to the cell) should be determined and, if necessary, used to decide how much time before the sampling shall start in order to maintain the 240 s and 480 s sampling probes of the chamber effluents to the gas analysis cell.

NOTE 3 Normally, this time is only a few seconds and no correction is needed.

The procedures for determination of delay time and response time are described in ISO 19702.

The flexible tube used to transport gases shall be built of chemically inert material with respect to analysed species and shall be resistant to temperatures of at least 180 °C for long periods of time. It shall be heated to at least 150 °C.

NOTE 4 A flexible heat stable tube of PTFE with inner diameter of 4 mm and a length of 2 m is recommended.

C.3.3 *FTIR* gas cell

The FTIR gas analysis cell shall have a volume of maximum 2 l in order to allow a short response time with the required volume capacity of the sampling. In consideration of the corrosivity of detectable gas species, a stainless steel or nickel-coated aluminium body and preferably massive nickel mirrors should be used. Gold-coated mirrors may be used, but an increased liability to corrosion should be considered.

NOTE The choice of the sampling flow rate in combination with cell volume should guarantee a short response time in order to have a sampling time not larger than 15 s.

C.3.4 *FTIR* spectrometer

The *FTIR* spectrometer shall have the following main characteristics:

a) an IR source stabilised at high intensity and temperature;

b) an interferometer with continuous scans and resolution better or equal to 4 cm^{-1};

NOTE 1 A wave number range between 500 cm^{-1} and 4 200 cm^{-1} is recommended;

c) a high-speed inner detector. Deuterated Triglycine Sulfate (DTGS) (ambient temperature) or Mercury-Cadmium Telluride (MCT) (additional cooling necessary) types should be used;

d) a scan interval ≤ 3 s;

e) an interval between spectra ≤ 15 s;

NOTE 2 To improve the accuracy at least 4 or 5 scans per spectrum are recommended.

f) A Minimum Detection Limit (MDL) for carbon dioxide of < 300×10^{-6} (300 ppm). A MDL for gases other than carbon dioxide of ≤15×10^{-6} (15 ppm).

C.4 Test environment

The test equipment shall be placed in a room with a draught-free environment, a temperature between 15 °C and 35 °C, and a relative humidity between 20 % and 80 %. The test chamber shall be placed under a hood able to extract the smoke from the test chamber after the end of each test. The discharge valve of the test chamber should be connected to an exhaust fan.

C.5 Conditioning

Before the preparation of the test specimen, samples shall be conditioned until constant weight (Δm < 0,1 % in 24 h) in a standard atmosphere of 23 °C ± 2 °C and 50 % ± 5 % R.H.

C.6 Pre-test conditions for the apparatus for Method 1

The operations of calibration and preparation of the equipment for the test, and also the procedures for carrying out the test, shall follow those specified in EN ISO 5659-2 with the following changes. It should be allowed to set the temperature of the *FTIR* sampling experimental setup as high as 165 °C ± 15 °C. It has to be checked that calibration and analysis are carried out at the same temperature. The filter, the flexible probe and the *FTIR* gas cell shall be heated so that the sample of effluent shall be stabilised to a temperature of 165 °C ± 15 °C. This condition ensures that the composition of gases produced from the combustion does not vary between the sampling probe and the analysis point.

C.7 Warnings

Take suitable precautions to safeguard the health of test operators.

Toxic or harmful gases may be given off during the exposure of the specimen to the specified test conditions.

The conditions of these tests involve high temperatures and produce combustion products with potential risks for skin, for propagation of the fire to external objects or to clothing. The operator shall wear protective gloves and safety goggles during the operations of insertion of the test specimen into the test equipment and during discharge of residues. The cone radiator and the electric elements should not be touched until they are cool.

The effectiveness of the discharge system in the equipment shall be checked before the beginning of the tests.

To keep the mirrors of the *FTIR* cell safe from aerosol particles, at the end of each test pump in pure nitrogen for at least 3 min with a flow rate around 4 l/min. Then check that the mirrors are correctly aligned before testing.

NOTE The optimum specimen/alignment value should be set and defined by the *FTIR* manufacturer during installation.

C.8 Smoke and gas testing using Method 1

C.8.1 Beginning of the test

Clean the inner walls of the smoke chamber, the supports of the furnace and the specimen holder. This procedure shall be carried out when the material for testing is changed so that gas analysis results are not influenced by chemical or physical interactions between the new material and the residues left from the material previously tested (see EN ISO 5659-2).

Clean also the inner sampling probe by blowing air in and then put a clean filter in the filtration cartridge before starting each test.

Set the equipment for the execution of the test following the specifications described in C.6 and check the stabilisation at the levels of temperature defined in C.6 for filter, flexible probe and cell.

Switch on the *FTIR* sampling pump, check and, if necessary, regulate the sampling flow rate. With the radiator cone off and using a dummy specimen as defined in EN ISO 5659-2 set the correct distance of 25 mm ± 1 mm between its surface and the base of of the radiator cone.

NOTE For intumescent materials, see EN ISO 5659-2.

Set the temperature of the radiator cone so that it corresponds, by previous calibration, to the radiating flux level needed for testing. Wait a stabilisation period of 30 min.

Set the technical parameters of the FTIR spectrometer for data collection:

— resolution: for example 4 cm^{-1};

— number of scans per spectrum: for example 4;

— recommended IR region for collecting spectra: 500 cm^{-1} to 4 200 cm^{-1}.

C.8.2 Test procedure

Perform the test according to the following sequence of operations:

— switch off the exhaust system; close the smoke chamber exhaust vent and the smoke chamber door. In this step the specimen holder shall contain the dummy specimen for the baseline recording;

— move the valve in order to sample inside the chamber;

— record the background spectrum of the initial chamber atmosphere;

— move the valve in order to sample outside the chamber;

— record the internal temperature of the chamber (it shall be 40 °C ± 5 °C at 25 kW/m^2 and 55 °C ± 5 °C at 50 kW/m^2);

— take out the test specimen from the standard conditioning atmosphere, weigh it alone and after wrapping it in aluminium foil;

— put the test specimen in the specimen holder;

— insert the protection screen;

— measure the sampling probe temperature with an interval period of 5 s between data points;

— take off the dummy specimen and put in the test specimen;

— take off the protection screen, close the chamber door and start the data recording system.

NOTE This procedure may vary in test facilities which have automatic protection screen removal.

The operations between the exposure of the radiator cone and the closing of the chamber door shall be done within 5 s.

Observe and record the times at which non-continuous flame (less than 10 s), ignition and extinction of the specimen occur.

The test period shall be always 20 min for smoke testing.

During this procedure, the smoke density data shall be collected in a continuous way as specified in EN ISO 5659-2.

The gases to be analysed shall have reached and filled the FTIR cell within 225 s – 255 s and 465 s – 495 s respectively.

C.8.3 End of test

— At the end of test period, open the exhaust valves and switch on the smoke exhaust system to clean the atmosphere of the smoke chamber;

— open the door of the chamber and insert the protection screen between the radiator cone and the specimen;

— take off the burnt specimen and put it under an exhaust hood for cooling.

C.8.4 Data acquisition

During each single test, the following parameters shall be noted and reported:

— the initial temperature of the chamber wall;

— the time of ignition (if it occurs) and the time of extinction (if it has ignited) of the test specimen;

— continually collected data of the temperature at the sampling probe with a maximum time interval of 5 s;

— FTIR spectra of atmospheres sampled at 240 s and 480 s;

— the internal pressure of the chamber if it exceeds 150 mm H_2O;

— the initial mass of the test specimen;

— further observations (For example: intumescence, glowing or melting of the test specimen during the test) and the times from the start of the test at which the observations were made.

C.9 Data treatment

For each gas listed in Table 1, concentration values at 240 s and 480 s, C_n, shall be calculated using the following formula:

$$C_{\mathrm{n}} = \left(\frac{P_{\mathrm{chamber}} \times M_{\mathrm{gas}}}{R} \right) \times \left(\frac{c_{\mathrm{gas}}}{T_{\mathrm{chamber}}} \right)$$

where

C_n is the concentration of measured gas species in kg/m^3 at 240 s and 480 s sampling probe;

P_{chamber} is the pressure of the chamber in “Pa” (commonly 101 325 Pa);

M_{gas} is the molar mass of the measured gas in kg/mol;

R is the gas constant (8,314 3 J mol^{-1} K^{-1});

c_{gas} is the volume fraction (dimensionless) of the measured gas as determined by the FTIR procedure;

T_{chamber} is the absolute temperature of the chamber at FTIR sampling probe in “K”.

NOTE For NO and NO_2, the concentrations determined of each of the two gases are added and the sum obtained is considered as NO_x. The concentration C_{n} is then converted into mg/m^3 (by multiplying by 10^6) and used for calculation of the CIT index following the procedure described in C.16 where the values are scaled from test conditions (chamber volume, test specimen area) to the reference scenario (scenario volume and material surface/mass application criteria).

C.10 Test report for Method 1

The information that shall be contained in the technical test report is as follows:

a) the name of laboratory;

b) the number and the reference of the test report;

c) the name and the address of the customer/producer;

d) the date of the test;

e) the identification of all the equipment, the software used and the operator;

f) the code or identification number of the material and its trade name;

g) the composition or characterisation of the material indicating, where possible, the thickness (expressed in millimetres), the mass (expressed in grams) and the density (expressed in kg/m^3). In case of assembled or multilayers materials, when possible, the nominal thickness and the density of each component shall be recorded;

h) the density of the composite or the mass per unit surface area. When available, the design and the description of the geometry of the test specimen shall be reported;

i) a description of the method of preparation of the test specimen; the dimensions of the exposed surface; whether a metallic retaining grid has been used; and details of any other special procedures that have been used;

j) any variations from the characteristics and the conditions indicated in this procedure shall be recorded. All deviations, which occurred during the test, shall be recorded.

The test results, for every test carried out, shall be reported as follows:

a) the time of ignition, expressed in seconds;

b) the list of the gases detected following the list specified in C.1;

c) The volume fractions (expressed as microlitre/litre) of each specified gas measured at 240 s and 480 s;

d) the corresponding concentrations (expressed in kg/m^3);

e) the CIT_G values at 240 s and 480 s;

f) any unusual or unexpected behaviour of the test specimen during the test, e. g. flashes, particle projection, melting or distortion of the test specimen;

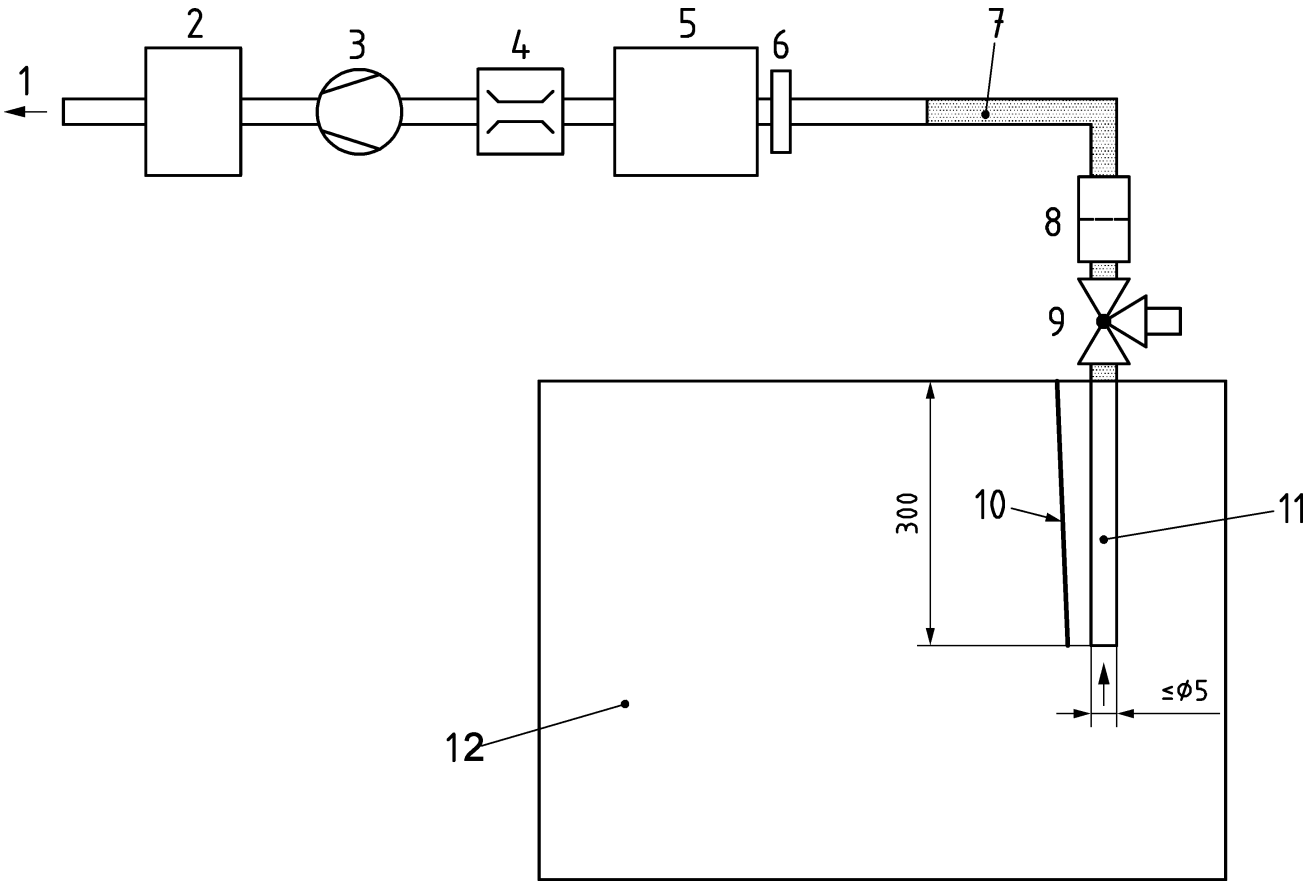
g) any difficulties met during the test.

For each product tested, the technical report shall include the following average value of the 3 replicate tests used:

h) the initial mass, final mass and mass loss of the test specimen;

i) the time of ignition;

j) the CIT_G values.



Key

1 specified flow rate
2 counter
3 pump
4 flow meter
5 FTIR gas cell (165 °C ± 15 °C)
6 cell protecting ≤ 3 µ filter
7 heated sampling line
8 heated filter
9 exhaust valve
10 thermocouple
11 sampling probe
12 EN ISO 5659-2
single smoke chamber

Figure C.1 — Smoke chamber and effluent sampling system for FTIR analysis (Method 1)

C.11 Use of alternative gas analysis techniques to FTIR

Other methods of sampling and analysis (such as NDIR, ion chromatography, chemiluminescence) may be used with Method 1 as alternatives to FTIR provided that they are shown to give equivalent results to FTIR in

reference tests according to NF XP-T90-210. Where alternative sampling and/or analytical techniques are used, the evidence for the equivalency claim shall be included with the test report.

C.12 Method 2 – Test apparatus

The test apparatus is detailed in NF X 70-100-2.

C.13 Test environment (Method 2)

The test equipment shall be placed in a test chamber with a draught free environment, at a temperature between 15 °C and 35 °C, and a relative humidity between 20 % and 80 %. The tubular furnace shall be placed under a hood able to extract the smoke from the chamber after the end of each test.

NOTE The discharge valve of the test chamber should be connected to an exhaust fan.

C.14 Conditioning of samples

Before preparation of the test specimen, samples shall be conditioned until constant weight (Δm < 0,1 % in 24 h) in a standard atmosphere of 23 °C ± 2 °C and 50 % ± 5 % R.H.

C.15 Test for gases using Method 2

The procedure for generation and analysis of fire effluents is described in NF X70-100-1.

A variety of gas analytical methods are specified as suitable for use in the NF X70-100-1 tubular furnace method; these methods are detailed for individual gases in Table C.3.

Where alternative sampling and/or analytical techniques are used the evidence for the equivalence shall be included with the test report.

Table C.3 — Analytical methods that may be used with Method 2

Gas	Method of analysis	Section of NF X70-100-1
CO	Non-dispersive infrared spectrometry	7.1.1
CO_2	Non-dispersive infrared spectrometry	7.1.2
HF	Spectrophotometry Specific electrode ionometry	7.2.1 7.2.2
HCl	Titrimetry using a silver electrode Ion chromatography	7.3.1 7.3.2
HBr	Titrimetry using a silver electrode Ion chromatography	7.4.1 7.4.2
HCN	Spectrophotometry Ion chromatography	7.5.1 7.5.2
SO_2	Ion chromatography	7.6
NO, NO_x	Chemiluminescence	7.7
NO_2	Ion chromatography	7.7

Other methods of analysis (such as FTIR) may also be used with Method 2 after a reference determination according to NF XP-T90-210 has been made to ensure that the alternative method is equivalent to those suggested in NF X70-100-1.

C.16 Calculations of *CIT*

C.16.1 Introduction

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 = [Precursor Term] × [Summation Term]

The precursor term is essentially a model or system parameter. The precursor term that is used in this document defines the fire model, such as the area of a product that is perceived to burn and the volume of the space into which the gaseous effluents flow. *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 (see Table C.1). The units of the precursor term are such as to generate a dimensionless *CIT*.

The reference concentrations C_i of the gas components in Table C.1 shall be used in all the calculations for *CIT* described below.

C.16.2 General products (CIT_G)

CIT_G is defined as follows:

$$CIT_G = \frac{0{,}51\ \mathrm{m}^3 \times 0{,}1\ \mathrm{m}^2}{150\ \mathrm{m}^3 \times 0{,}004225\ \mathrm{m}^2} \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

where the model is

— 0,1 m^2 exposed product burning;

— the gaseous effluents disperse into 150 m^3;

— the volume of the test chamber is 0,51 m^3;

— the exposed surface area of the test specimen is 0,004 225 m^2.

c_i is the concentration measured in mg·m^{-3} of the i^{th} gas in the EN ISO 5659-2 smoke chamber;

C_i is the reference concentration measured in mg·m^{-3} of the i^{th} gas.

This expression simplifies to:

$$CIT_G = 0{,}0805 \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

NOTE The volume of 150 m^3 is a nominal volume assumed to relate to some train carriages in operation.

The pre-cursor term does not consider the effect of stratification, dispersion outside the carriage, ventilation and/or condensation on cold surfaces.

C.16.3 Non-listed products (CIT_{NLP})

CIT_{NLP} shall be measured with the tube furnace according to NF X70-100-1 (with analysis of the 8 gases listed in Table 1) and is defined as follows:

$$CIT_{NLP} = \frac{450\,\mathrm{g}}{150\,\mathrm{m}^3 \times N} \times \sum_{i=1}^{i=8} \frac{Y_i}{C_i}$$

where

the model is 450 g material burning and the gaseous effluents disperse into 150 m^3.

N is a reduction factor with a value of 3 representing the assumed fraction of the toxic potency which is realised in a fire.

Y_i is the yield of the i^{th} gas in mgg^{-1} in the NF X70-100-1 tube furnace;

C_i is the reference concentration of the i^{th} gas in $mg{\cdot}m^{-3}$.

This expression simplifies to:

$$CIT_{NLP} = 1\frac{g}{m^3} \sum_{i=1}^{i=8} \frac{Y_i}{C_i}$$

NOTE The volume of 150 m^3 is a nominal volume assumed to relate to some train carriages in operation.

The pre-cursor term does not consider the effect of stratification, dispersion outside the carriage, ventilation and/or condensation on cold surfaces.

Annex D
(normative)

Protocol for test specimen preparation in standard tests

D.1 Protocol for specimen preparation for tests according to EN ISO 5659-2 and ISO 5660-1

The product shall be tested in relation to the surface exposed in the real conditions of use. In the case where both surfaces are exposed and the product is not symmetrical, each surface has to be tested.

The specimens shall be representative of the product to be tested. They shall be cut, sawn, formed or printed from the same sample area of material and shall be the same thickness and density as in end use, as far as is practicable.

Covering materials shall be prepared to be as similar to end use conditions as practicable. The test specimen may include adhesives, varnishes, substrates and supports. Details of test specimen preparation shall be reported.

The edges of the test specimen shall be protected with a steel retainer frame.

A minimum of 3 test specimens will be required. The assessment rules defined in EN ISO 5659-2 shall also apply to calculation of CIT values

NOTE In case of intumescent materials, it may be necessary to make preliminary tests, in which case additional test specimens will be required.

D.2 Protocol for specimen preparation of upholstered furniture assembled products for tests according to EN ISO 5659-2 and ISO 5660-1

D.2.1 Scope and field of application

The test specifications provided in EN ISO 5659-2 “Smoke generation — Single chamber test” and respectively in ISO 5660-1 “Heat release rate — Cone calorimeter method” and in this document shall be followed for performing a standardised test according to the fire protection on railway vehicles application protocol.

Sub-clause D.2.2 provides instructions for the preparation of specimens from upholstered furniture (including mattresses) to make them ready for testing. Basic specimen preparation instructions are presented.

D.2.2 Preparation of test specimens

D.2.2.1 General

Test specimens shall be prepared in accordance with either the specifications in EN ISO 5659-2, or ISO 5660-1, as appropriate, and in accordance with D.2.2.2. Table D.1 summarises test specimen details.

Table D.1 — Dimensions and preparation details of test specimen

Test specification	Specimen Size [mm]	Total thickness [mm]	Size of covering and interlayer [mm]	Maximum size of aluminium foil [mm]	Aluminium foil side towards the specimen
EN ISO 5659-2: Smoke generation — Single chamber test	75 × 75	25	75 × 75	145 × 145	dull
ISO 5660-1: Heat release rate — Cone calorimeter method	100 × 100	50	100 × 100	210 × 210	shiny

D.2.2.2 Test specimen preparation

Foam blocks shall be cut out to obtain a total thickness (foam + covering + interlayer) not greater than stated in Table D.1.

The covering and interlayer shall be cut according to the size given in Table D.1. Do not cut on the bias. If the fabric weave is such that the threads in the two directions do not lie at 90° to each other, do not cut the sample along threads in both directions, since a skew specimen would result.

NOTE For test specimens with glued parts, the producer should prepare the sample.

Cut a square of aluminium foil. The “Maximum size of aluminium foil” is given in Table D.1. Place the specimen at the centre on the foil, with the unexposed side on the aluminium foil. Hold the test specimen firmly in place and pull each side of the foil up. Form the corners by holding the foil firmly in contact with the corner of the specimen. Pull the corner of the foil and make a 45° fold at each corner. Finally, pull the corners flat against two sides of the specimen and pat all sides down flat against the specimen. After mounting the test specimen in its holder, excess aluminium foil shall be cut away.

D.2.2.3 Reporting of Mass

The mass of each foam block, interliner and covering fabric shall be measured and the relevant identification marks shall be noted. These shall be reported.

Measure and record the mass of the wrapped test specimen.

D.3 Protocol for test specimen preparation for flame spread testing

D.3.1 Scope and field of application

This section provides instructions for the preparation of specimens for lateral spread of flame tests according to ISO 5658-2 and radiant panel tests for flooring according to EN ISO 9239-1.

D.3.2 Test specimen preparation

a) For the lateral spread of flame testing, ISO 5658-2 explains the way to prepare the specimen for testing and no additional requirements shall be used;

b) for the radiant panel tests for flooring according to EN ISO 9239-1, the test specimens should be tested wherever possible as close as possible to the thickness conditions of the end use. Products (including multi-layer products) with thickness more than 25 mm should be reduced to the thickness of 25 mm.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC[1].

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for HS Rolling Stock, Table ZA.2 for CR Locomotives and Passenger Rolling Stock and Table ZA.3 for the HS/CR TSI Safety in Rail Tunnel, confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 – Correspondence between this European Standard, the HS TSI RST published in the OJEU dated 26 March 2008 and Directive 2008/57/EC

Clause/ sub-clauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4. Characterisation of the subsystem 4.2 Functional and technical specification of the subsystem 4.2.7 System protection § 4.2.7.2.2 Measures to prevent fire 7.1 Implementation of the TSI §7.1.6 Measures to prevent fire. Materiel conformity Annex E – Table E1-§4.2.7.2 Fire safety	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.4 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §8 2.4.2 Reliability and availability	Operation category 2 and 3, as defined in 5.2.1 and 5.2.2 of EN 45545-1:2013, correspond respectively to the Category A and B Fire safety of the HS-RST-TSI.

[1] This Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directives 96/48/EC 'Interoperability of the trans-European high-speed rail system' and 2001/16/EC 'Interoperability of the trans-European conventional rail system' and revisions thereof by 2004/50/EC 'Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system'

Table ZA.2 – Correspondence between this European Standard, the CR LOCO&PAS RST TSI published in the OJEU on 26 May 2011 and Directive 2008/57/EC

Clause/ sub-clauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4.Characterisation of the Rolling stock subsystem 4.2 Functional and technical specifications of the subsystem 4.2.10 Fire safety and evacuation § 4.2.10.1 General and categorisation §4.2.10.2 Material requirements	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.4 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §8 2.4.2 Reliability and availability	Operation category 2 and 3, as defined in 5.2.1 and 5.2.2 of EN 45545-1:2013, correspond respectively to the Category A and B Fire safety and evacuation of the TSI.

Table ZA.3 – Correspondence between this European Standard, the SRT TSI published in the OJEU dated 7 March 2008 and Directive 2008/57/EC

Clause/ sub-clauses of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard applies	4.Characterisation of the subsystem 4.2 Functional and technical specifications of the subsystem 4.2.5. Subsystem rolling stock 4.2.5.1. Material properties for rolling stock	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.3, 1.1.4 1.3 Health Clause 1.3.2 1.4 Environmental protection Clause 1.4.2 2 Requirements specific to each subsystem 2.4 Rolling stock 2.4.1 Safety §8 2.4.2 Reliability and availability	Operation category 2 and 3, as defined in 5.2.1 and 5.2.2 of EN 45545-1:2013, correspond respectively to the Category A and B Fire safety of the TSI.

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Bibliography

96/603/EC: Commission Decision of 4 October 1996 establishing the list of products belonging to Classes A 'No contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/EEC on construction products.

2008/57/EC, Directive 2008/57/EC of the European Parliament and of the Council of 17 June 2008 on the interoperability of the rail system within the Community.

96/603/EC: Commission Decision of 4 October 1996 establishing the list of products belonging to Classes A 'No contribution to fire' provided for in Decision 94/611/EC implementing Article 20 of Council Directive 89/106/EEC on construction products.

2008/232/EC, Commission Decision of 21 February 2008 concerning the technical specification for interoperability relating to the rolling stock subsystem of the trans-European high-speed rail system referred to in Article 6(1) of Directive 96/48/EC.

2011/291/EU, Commission Decision of 26 April 2011 concerning a technical specification for interoperability relating to the rolling stock subsystem — 'Locomotives and passenger rolling stock' of the trans-European conventional rail system.

ISO 9705, *Fire tests — Full-scale room test for surface products*

NF XP-T90-210*, Protocole d'évaluation initiale des performances d'une méthode dans un laboratoire*