

Standard Category 1

S1085

Fire Safety Performance of Materials - Stations and Tunnel Infrastructure

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1 Purpose

The purpose of this standard is to define the requirements for the fire safety performance of materials, installed on the London Underground (LU) Stations and Tunnel Infrastructure.

The business objective of this standard is to ensure that the risk to which the public and employees are exposed is controlled to a level that is as low as reasonably practicable.

2 Scope

This standard specifies the requirements for materials within all locations as listed in LU Standard S1086 with regard to:

- a) Combustibility
- b) Smoke emission
- c) Toxic fume emission.

Rolling stock shall comply with BS 6853, Category 1a, with the additions as listed in Attachment C.

Note: This standard does not cover the wider aspects of fire engineering. It may be necessary to invoke other London Underground, National or European Standards to cover fully all aspects of fire safety for a particular application. Guidance is available in G085.

2.1 Installations

This standard shall apply to installations:

- a) In stations covered by The Fire Precautions (Sub-surface Railway Stations) England Regulations 2009 and LU Standard S1086;
- b) In running tunnels;
- c) In other locations that are not effectively separated from locations covered by a) or b) above;
- d) In all other locations where risks from combustibility, smoke or toxic fumes are not controlled to a level as low as reasonably practicable by other means.

2.2 Separation

Locations will be considered to be 'effectively separated' if they are either:

- a) completely divided from the relevant stations and/or running tunnels by construction complying with Table 9, and there is no personnel access via that construction or;
- b) configured such that it can be demonstrated that the stations/tunnels are adequately protected by means of fire and smoke control, in accordance with the relevant British Standards. This will require the support of a Fire Strategy, prepared, assured and accepted to be in accordance with LU standard 1-080.

3 General Requirements

All tests for combustibility, smoke emission and toxic fume shall be undertaken by test houses accredited by the National Accreditation bodies within the relevant European Union country. A copy of any test reports shall be made available to LU on request.

All materials shall be tested to replicate their intended application, i.e. a panel or surface to be used free-standing, with no backing or substrate, shall be tested in that manner. Similarly, where a panel or coating is to be used on a particular substrate, that substrate shall be used as backing for the sample to be fire tested. If there are direct application rules available, testing of one substrate can be applicable to other substrates (i.e. BS EN 13238).

Note: Where it is intended to use the material on a number of substrates or in different applications, it may be prudent to consult the testing body so that the desired range of applications can be covered by the minimum amount of physical testing. It is usually appropriate (for assurance purposes) for the relevant test laboratory to issue a report containing a 'Field of application' that defines the allowed use of the material, substance or treatment, in the context of this standard.

3.1 Toxic Fume emission – All products

Toxic fume emissions shall be tested according to the following process:

- a) Evidence shall be provided to confirm that all combustible materials do not contain the following elements, which are known to potentially give rise to toxic fume emission: Halogens, Nitrogen, Sulfur. This evidence shall be in the form of qualitative analysis using x ray fluorescence spectroscopy, and the instrument used shall be able to detect elements with atomic numbers down to Nitrogen. All layers of composite materials shall be tested. This test may however be omitted if the tests described in (b) or (c) below are undertaken;
- b) If any of the proscribed elements are detected, the potential for toxic fumes to be produced during combustion shall be quantified using either the area based test detailed in Attachment A.2 for surfaces or the mass based test detailed in Attachment A.1. The requirement shall be that the calculated Immediately Dangerous to Life or Health Concentrations (IDLH) level of the gases detected, as detailed in the The National Institute for Occupational Safety and Health (NIOSH) Guide to Chemical Hazards, shall not impair escape, for the intended location or environment.

Note: The toxic fume test methodology is described in Attachment A of this standard.

- c) Paint materials can be tested in accordance with BS EN 45545-2:2013+A1:2015, Method 1. The requirement shall be a maximum Conventional Index of Toxicity (CIT) value of 0.75. Additionally, the parts per million (PPM) values of the detected gases shall be recorded.
- d) In cables, only the outer sheathing materials shall be tested for toxic fume emissions when separated by a non-combustible layer (i.e. continuous layers of metal, steel wire armour, steel tape armour, concentric conductors which offer mechanical protection or fire resistant tapes).

3.2 Vertical & ceiling surfaces

3.2.1 Combustibility - walls and ceiling

All public facing vertical wall and ceiling surfaces shall meet the requirements of class B-s1, d0, when tested in accordance with BS EN 13501-1. Alternatively, products shall comply with the requirements of an index of performance (I) not exceeding 12 and sub-index (i_1) not exceeding 6 when tested to BS 476: Part 6 and class 1 to BS 476: Part 7.

3.2.2 Combustibility - other than walls and ceiling (e.g. small panels)

All vertical and horizontal prone surfaces other than walls and ceilings are considered compliant with combustibility requirements if they meet the criteria given above in clause 3.2.1. Alternately, the following tests can also be carried out to demonstrate compliance:

Test Method	Requirement
ISO 5658-2	$CFE \geq 20 \text{ kWm}^{-2}$ with no flaming droplets/particles
ISO 5660-1: 50 kWm^{-2}	$MARHE \leq 60 \text{ kWm}^{-2}$

Table 1 – Combustibility requirements for surfaces other than walls and ceiling

3.2.3 Smoke Emission

Location	Test method	Requirement
Option 1		
Vertical and ceiling surfaces in tunnels	S1085, Attachment B.6	$A_o(\text{ON}) < 2.4 \text{ sq.m/burn area}$ $A_o(\text{OFF}) < 3.6 \text{ m}^2/\text{burn area}$
Vertical and ceiling surfaces in stations	S1085, Attachment B.6	$A_o(\text{ON}) < 3.6 \text{ m}^2/\text{burn area}$ $A_o(\text{OFF}) < 5.4 \text{ m}^2/\text{burn area}$
Option 2		
Vertical and ceiling surfaces in stations	EN ISO 5659-2: 50 kWm^{-2} , without pilot flame	a) D_s maximum, dimensionless, ≤ 150 b) VOF_4 minutes ≤ 300

Table 2 – Smoke emission requirements for all vertical and ceiling surfaces

3.3 Flooring surfaces

3.3.1 Combustibility

All flooring surfaces shall comply with the requirements of class B_{fl} outlined in BS EN13501-1 or, alternatively, BS476: Part 7, class 2.

3.3.2 Smoke Emission

Location	Test method	Requirement
Option 1		
Flooring surfaces in tunnels	S1085, Attachment B.7	$A_o < 250 \text{ m}^2/\text{m}^2$
Flooring surfaces in stations	S1085, Attachment B.7	$A_o < 350 \text{ m}^2/\text{m}^2$
Option 2		
Flooring surfaces	EN ISO 5659-2: 25 kWm^{-2} , with pilot flame	D_s maximum, dimensionless, ≤ 150

Table 3 – Smoke emission requirements for floor composites

3.4 Seats

The backs of seats on station platforms shall be considered as vertical surfaces and the bases of seats on station platforms shall be considered as supine surface, i.e. flooring mode. If a seat is formed from a single fabrication, the material shall meet the requirement for vertical surfaces.

3.5 Cables

Cables can be considered compliant for combustibility and smoke emission by meeting the requirements listed in one of the following options.

3.5.1 Option 1

3.5.1.1 Combustibility & smoke emission

Cables that are subject to the Construction Products Regulation (CPR) shall meet the test requirements of class C_{ca} -s1a,d0,a3 as defined in BS EN 13501-6.

3.5.2 Option 2

3.5.2.1 Combustibility

The burn height results obtained from tests described in the following standards, shall comply with the values given below in Table 4.

Cable overall diameter	Test method	Requirement
greater than 12mm	BS EN 60332-3-24	$< 2.5 \text{ m}$
equal to or less than 12mm	BS EN 60332-3-25	$< 2.5 \text{ m}$

Table 4 – Flame spread requirements for cables

There should not be any flaming droplets and/or particles during the first 10 minutes of the test. Flaming droplets and/or particles are defined in BS EN 13501-6.

Note: If a cable is fully encased in a non-combustible enclosure (i.e. steel conduit), there is no need to comply with the requirements of flaming droplets and/or particles.

Alternatively, for cables which have an overall diameter of $< 3.5 \text{ mm}$, the vertical ladder tests described above may be substituted for a temperature index test, according to the criteria given below in Table 5.

Standard	Radial Thickness of Sheath	Requirement
BS EN ISO 4589-3	>0.4mm	280 °C
	<0.4mm	350 °C

Table 5 – Combustibility requirements for small diameter cables

3.5.2.2 Smoke Emission

The maximum permitted smoke emission which is related to overall cable diameter as tested in accordance with BS EN 61034-2 shall be:

- a) $A_o(ON) < 0.7[\tan^{-1}(d/45)/45 - \tan^{-1}(d)/2025]$
- b) $A_o(OFF) < 1.8A_o(ON)$

where d = cable diameter in mm. A minimum of two tests shall be undertaken. If one result represents a failure, a third test shall be required to confirm the result.

3.6 Non-listed items

Small electro-technical components and all other miscellaneous items and materials not included in 3.2, 3.3, 3.4 and 3.5 shall be tested on the basis that the results obtained will relate to the composite construction of the particular item unless otherwise stated.

The results of tests, described in the following standards for extensive and grouped usage, shall comply with the values given below in Table 6:

Test Method	Requirement
<i>Combustibility Test Options</i>	
BS EN ISO 4589-2: Limiting Oxygen Index	LOI > 40% or
BS EN ISO 4589-3: Temperature Index	TI > 350 °C
<i>Smoke Emission Test Options</i>	
S1085, Annex B.5	A0 < 0.005 m ² /g or
EN ISO 5659-2: 25 kWm ⁻² , with pilot flame	Ds maximum, dimensionless, ≤ 150

Table 6 – Flammability and smoke emission requirements for non-listed items (extensive and grouped usage)

The results of tests described in the following standards for limited and dispersed usage shall comply with the values given below in Table 7:

Test Method	Requirement
<i>Combustibility Test Options</i>	
BS EN ISO 4589-2: Limiting Oxygen Index	LOI > 30% or
BS EN ISO 4589-3: Temperature Index	TI > 300 °C
<i>Smoke Emission Test Options</i>	
S1085, Annex B.5	A0 < 0.02 m ² /g or
EN ISO 5659-2: 25 kWm ⁻² , with pilot flame	Ds maximum, dimensionless, ≤ 300

Table 7 – Flammability and smoke emission requirements for non-listed items (limited and dispersed usage)

3.7 Commentary on smoke emission tests

The smoke emission test methodology for items detailed in clauses 3.2, 3.3, 3.4 and 3.6 is described in Attachment B of this standard.

If a risk assessment is required for non-compliance with smoke emission, it can only be conducted using data from the test methodology described in Annex B. This risk assessment must form part of a concession application that details other mitigations.

The smoke emission results when tested to EN ISO 5659-2 will only be valid for the specified thickness in the test report.

3.8 Non-applicable and excepted materials and locations

The requirements in this standard shall not apply to:

- a) items which are temporarily used and then removed from public areas (including tunnels) prior to start of traffic hours;
- b) consumables, portable electrical equipment, portable furniture and personal effects where these items are contained within staff accommodation, ticket offices and administration areas and where those areas are covered by fire detection and alarm systems compliant with LU Standards;
- c) items within public and non-public locations, including retail units, where those areas are fitted with fire detection and suppression systems compliant with LU standards. Escalator Machine Chambers (EMCs) are not part of this exemption. Requirements for a smoke management system shall be determined from the Fire Strategy for the specified location in accordance with LU standard 1-080;
- d) minor use materials – single, or joined items, providing they have:-
 - i) a total mass not more than 100g or;
 - ii) an area (in the case of surface coatings) of not greater than 0.2m²;
- e) material samples which differ only in colour from those already tested, providing the colourant does not exceed 5% (w/w);
- f) Non-combustible materials or materials of limited combustibility as defined in The Building Regulations, Approved Document B;
- g) Materials and enclosures within a fire-resistant structure listed in Table 8. The requirements of a fire-resistant structure are given in Table 9.

Excepted Materials	Conditions
1) All materials	When located within a fire-resistant, non-public room where the volume of the room is <120m ³ ; and where a fire detection and alarm system compliant with LU standards is installed to cover that room.
2) All materials	When located within a fire-rated, non-public room where the volume of the room is <240m ³ ; where the room has multiple means of escape, of which two will be opposite to each other; and where a

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