Transport for London
London Underground

Category 1 Standard

1-085 Fire safety performance of materials

Please read the Written Notices attached to this standard

Issue: A3 **Issue date:** March 2011

MAYOR OF LONDON

Contents

1 Purpose

1.1 The purpose of this Standard is to define the requirements for the fire safety of materials, in terms of flammability, smoke emission and toxic fume emission, installed on the London Underground (LU) network:

1.2 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

2.1 This standard specifies the requirements for materials installed in underground locations with regard to:

a) Flammability (including the risk of explosion);
b) Smoke emission;
c) Toxic fume emission.

Note:	This standard does not cover the wider aspects of fire engineering, and 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.

2.2 This standard shall apply to installations:

a) In stations covered by Section 12 of the Fire Precautions (Sub-Surface Railway Stations) Regulations 1989 and 1-086;

b) In passenger and engineering trains;

c) In running tunnels;

d) In other locations that are not effectively separated from locations covered by a) or c) above;

e) In all other locations where risks from flammability, smoke or toxic fumes are not controlled to a level as low as reasonably practicable by other means..

2.3 Guidance is available in G-085.

2.4 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 5, 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 1-080.

2.5 This issue of the standard supersedes 1-085 A2

3 Requirements

3.1 General

3.1.1 All tests required under 3.2, 3.3 and 3.4 shall be undertaken by test houses accredited by the National Accreditation bodies within the relevant European Union country.

3.1.2 A copy of any test reports shall be made available to LU on request.

3.2 Rolling Stock

3.2.1 General

Rolling stock shall comply with BS 6853, Category 1a with the following additions.

3.2.2 Technical liquids

Technical liquids (including electrical components) shall be subject of a risk assessment to quantify the risks associated with fire.

3.2.3 Flammable gas

3.2.3.1 Pressurised flammable gas installations shall not be used.

3.2.3.2 Battery installations and all other flammable gas installations not covered by 3.2.3.1 shall be the subject of separate risk assessment for every application.

Note:	Guidance is given in LU Guidance Document G-085

3.2.4 Flat Surfaces

3.2.4.1 Flat surfaces shall be subject to toxic fume test B2 in Annex B of BS 6853. In order to ensure that the amount of toxic gas produced is above the threshold of detection, test samples shall have a mass of combustible material (as opposed to inert substrate) of not less than 5g.

3.2.4.2 If the requirement in 3.2.4.1 is not practical (on the basis of low mass per unit area), then the test B1 in BS 6853 shall be used. The resulting mass based R value shall be converted to an area based R value by scaling using the mass per unit area of the combustible material. The pass or fail criteria shall be against the area based R value requirement in the relevant table in BS 6853. The basis for conversion shall be: Calculated B2 R value = Measured B1 R value x (mass per unit area [g/sq.m.]/1000). A single sample shall be tested in the tube furnace, representing the percentage components of any composite material.

3.2.4.3 If B2 method is used it shall be ensured that samples taken to determine toxicity performance include all gases liberated during the testing process.

Note:	An appropriate method to be used could be a fan to ensure all gases are mixed.

3.3 Locations other than Rolling Stock

3.3.1 Vertical & ceiling surfaces and flooring surfaces in tunnels and in stations

3.3.1.1 All vertical and ceiling surfaces shall comply with the requirements Classes B, d0, in BS EN 13501-1 or alternatively BS 476Pt 6, (i1 < 6; I < 12) and BS 476Pt 7) Class 1.

3.3.1.2 All flooring surfaces shall comply with the requirements of Class B_{fl} in BS EN13501-1 or alternatively BS476 Pt 7 Class 2

3.3.1.3 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.

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 Body to issue a 'Field of application' that defines the allowed use of the material, substance or treatment, in the context of this Standard.

3.3.1.4 Toxic fume emissions shall be tested according to the following two stage 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, Sulphur. 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 test described in (b) below is 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 test B2 in BS 6853 for surfaces, or the mass based B1 test for other profiles and using a weighted summation of the 8 gases detailed in BS 6853. The requirement shall be that the calculated IDLH level of the gases detected, as detailed in the NIOSH Guide to Chemical Hazards, shall not impair escape, for the intended location/environment.

Note 1:	The R values in BS 6853 are not necessarily applicable for non-rolling stock applications, due to the larger dispersal volumes in stations.
Note 2:	If the requirements of BS 6853 category 1a are met, then toxic fume compliance is assumed.

3.3.1.5 The smoke density results shall comply with the values in Table 1: A minimum of two tests shall be undertaken. If one result represents a failure, a third test shall be required to confirm the result.

Location	Test	Requirement
Vertical and ceiling surfaces in tunnels	BS6853 D8.4	Ao(ON) < 2.4sq.m/burn area: Ao(OFF) < 3.6 sq.m/burn area
Flooring surfaces in tunnels	BS6853 D8.6	Ao < 250 sq.m/sq.m
Vertical and ceiling surfaces in stations	BS6853 D8.4	Ao(ON) < 3.6 sq.m/burn area Ao(OFF) < 5.4 sq.m/burn area
Flooring surfaces in stations	BS6853 D8.6	Ao < 350 sq.m/sq.m

Table 1 – Smoke emission requirements

3.3.2 Seats

3.3.2.1 The backs of seats on station platforms shall be considered as vertical surfaces on stations and treated in accordance with 3.3.1.

3.3.2.2 The bases of seats on station platforms shall be considered as flooring surfaces on stations and treated in accordance with 3.3.1 If a seat is formed from a single fabrication, the material shall meet the requirement detailed in 3.3.2.1.

3.3.2.3 Toxic fume requirements as detailed in 3.3.1.4.

3.3.3 Cables

3.3.3.1 The burn height results in tests described in the following standards shall comply with the values in Table 2.

Cable overall diameter	Standard	Requirement
greater than 12mm	BS EN 60332-3-24	< 2.5m
equal to or less than 12mm	BS EN 60332-3-25	< 2.5m

Table 2 – Flame spread requirements for cables

Note:	For cables with an overall diameter <3.5mm there is the option of undertaking a temperature index test on the outer sheathing material, in place of the vertical ladder test detailed in 3.3.3.1, as below.

Standard	Radial Thickness of Sheath	Requirement
BSEN ISO 4589-3	>0.4mm	280 deg C
	<0.4mm	350 deg C

3.3.3.2 The maximum permitted smoke emission, in accordance with BS EN 61034-2, related to overall cable diameter, shall be:

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

b) $Ao(OFF) < 1.8Ao(ON)$

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.

3.3.3.3 All cables shall meet the same requirements as regards burning drips and debris as the surfaces on which they run, as stated in 3.3.1.1. Any burning drips or debris observed during testing shall be reported.

3.3.3.4 Toxic fume requirements as detailed in 3.3.1.4

3.3.4 Non-listed items

3.3.4.1 Electro-technical components and all other miscellaneous items and materials not included in the locations described in 3.3.1, 3.3.2 and 3.3.3 shall be tested on the basis that the test results shall be assumed to relate to the composite item unless otherwise stated.

3.3.4.2 The results of tests described in the following standards for extensive and grouped usage shall comply with the values in Table 3:

Standard	Test	Requirement
BS EN ISO 4589-2	Oxygen/Temperature Index	LOI > 40%.or TI > 350^{o}C
BS 6853	D8.3	A0 < 0.005 sq.m/g

Table 3 – Flammability and smoke emission requirements for non-listed items (extensive and grouped useage)

3.3.4.3 The results of tests described in the following standards for limited and dispersed usage shall comply with the values in Table 4:

Standard	Test	Requirement
BS EN ISO 4589-2	Oxygen/Temperature Index	LOI > 30%.or TI > 300^{o}C
BS 6853	D8.3	A0 < 0.02 sq.m/g

Table 4 – Flammability and smoke emission requirements for non-listed items (limited and dispersed useage)

3.3.4.4 Toxic fume emission requirements shall comply with 3.3.1.4.

3.4 Non-applicable and excepted materials and locations

3.4.1 The requirements in this standard shall not apply to:

a) stations which are not within the scope of 1-086;

b) items which are not left in place in public areas (including tunnels) during traffic hours;

c) materials located within non-public rooms where the volume of the room is <75m^3; where the rooms' structure meets the requirements of Table 5 below; and where a fire detection and alarm system compliant with LU Standards is installed that covers that room;

d) materials located within enclosures where the enclosure structure meets the requirements of Table 5 below, except when additional requirements are identified and detailed in clause 3.4.2;

Profile	Standard	Performance Criteria (BS EN 13501-2)
Walls and glazing	BS EN 1364-1	EI (1 hour)
Ceilings	BS EN 1364-2	EI (a↔b) (1 hour)
Floors	BS EN 1365-2	REI (1 hour)
Doors	BS EN 1634-1	EI (1 hour)
Ducts/Cable Entries	BS EN 1366-1	E1 (i↔o) ve,ho S (1 hour)
Dampers	BS EN 1366-2	EI (1 hour)

Table 5 – Requirements for fire resistant structures

e) 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;

f) Retail stock, consumables, portable electrical equipment, portable furniture and personal effects kept within retail units where those units are fitted with fire detection and suppression systems;

g) minor use items **–** single, or joined items, providing they have:-
   i) a total mass not more than 100g and;
   ii) an area (in the case of surface coatings) of not greater than 0.2sq.m;

h) material samples which differ only in colour to those already tested, providing the colourant does not exceed 5% (w/w).

3.4.2 Checks shall be made against asset standards for specific requirements, as regards particular rooms and enclosures (e.g. for signalling equipment). These may require the application of this Standard to locations that would otherwise be out of scope, according to Clause 3.4.1 (above).

3.5 Evidence of compliance

3.5.1 Compliance with the requirements of this standard shall be demonstrated to LU by each party contracted to LU. Additionally LU may audit compliance as part of its surveillance regime.

4 Responsibilities

Infrastructure companies, PFI Projects shall be responsible for maintaining their own registers of compliant products with design registrations and auditable trails relating to approvals.

The Fire Engineer, London Underground is responsible for:

a) the custodianship and quality of this standard, and for its programmed review;
b) ensuring that the content is appropriate and correct for the purposes of the standard;
c) Operation of the Waiver process, as described in LU procedure for concessions.

The LU Procurement agent shall be responsible for incorporating the requirements of this engineering standard in any contract to which it is relevant and shall stipulate that a programme of audits are implemented by the contractor which ensures that these requirements are complied with.

5 Supporting information

5.1 Background

5.1.1 The requirements of this standard are separate from and independent of the fire resistance, fire protection and fire prevention requirements of The Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009, excepting paragraphs 8(1) and 8(2). In particular, a materials installation that complies with those Regulations may not necessarily comply with this standard – this is, in part, because the Regulations do not address the smoke and toxic fume emission requirements, which are covered in this standard.

5.1.2 Attention is brought to this extract from The Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009:

"*Materials used in internal construction of premises*

8.—(1) Any material which is used in the construction of an internal wall or ceiling in any public area must be of limited combustibility".

5.1.3 The definition of "limited combustibility" can be found in the guidance to the Regulations, which refers to the England & Wales Building Regulations Approved Document B. The definition of 'Limited combustibility' within the current version of this document can be found in Table A7 of that Document.

5.1.4 Users of this Standard should note that compliance with the requirements in the Standard would not necessarily achieve compliance with this express legal requirement. The technical criteria outlined in the extract from the legislation and the associated governmental guidance reproduced above are therefore to be considered as applying to all materials used in the construction of an internal wall or ceiling in any public area of all railway stations within the scope of this Standard.

5.1.5 Thin materials which are used to line, cover or coat an internal wall or ceiling need not comply with this requirement, being covered by Regulation 8(2) which is met by compliance with the requirements in 1-085.

5.2 Safety considerations

5.2.1 Failure to meet the standards set in this document may mean that an installation does not meet the requirements of the Fire Precautions (Sub-Surface Railway Stations)

Regulations 1989, paragraphs 8(1), 8(2), 8(3) and 8(4) or other safety-related legislation.

6 References

6.1 References

6.1.1 Statutory documents

Document no.	Title
SI 1989/ 1401	The Fire Precautions (Sub-Surface Railway Stations) Regulations 1989
SI 2009/ 782	The Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009

6.1.2 British Standards

Document no.	Title
BS 4422 1	Glossary of Terms associated with fire. General terms and phenomena of fire
BS EN ISO 4589-3	Plastics. Determination of burning behaviour by oxygen index. Elevated temperature test
BS 6853	Code of practice for fire precautions in the design and construction of passenger carrying trains
BS 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
BS EN 60332-3-25	Tests on electric and optical fibre cables under fire conditions — Part 3-25: Test for vertical flame spread of vertically-mounted bunched wires or cables — Category D
BS EN ISO 4589-2	Plastics. Determination of burning behaviour by oxygen index. Part 2 Ambient temperature test.
BS EN 13501	Fire classification of construction products and building elements – Part 1 Classification using test data from reaction to fire tests
BS EN 50268-1	Common test methods for cables under fire conditions. Measurement of smoke density of cables under defined conditions. Apparatus
BS EN 61034-2	Measurement of smoke density of cables burning under defined conditions Part 2: Test procedure and requirements
BS EN 1364-1	Fire resistance tests for non-load bearing elements. Walls
BS EN 1364-2	Fire resistance tests for non-load bearing elements. Ceilings
BS EN 1365-2	Fire resistance tests for non-load bearing elements. Floors and roofs.
BS EN 1634-1	Fire resistance for doors and shutter assemblies. Fire doors and shutters
BS EN 1366-1	Fire resistance tests for service installations. Ducts
BS EN 1366-2	Fire resistance testing of tests for service installations. Fire dampers
BS EN 13501-2	Fire classification of construction products and building elements. Classification using data from fire resistance tests, excluding ventilation services.

6.1.3 LU company documents

Document no.	Title
1-622	Glossary of terms and abbreviations
G-085	Code of practice – Fire Safety of Materials and Fire Safety of Specific Items and Materials Used in the Underground

Document no.	Title
1-086	Fire safety classifications of stations

6.2 Abbreviations

The following abbreviations are created:

d) within London Underground's Glossary of Terms (1-622) (a Category 1 Standard);
e) from published sources that are clearly identified.

Abbreviation	Definition	Source
IDLH	Immediately Dangerous to Life or Health	a
LOI	Limiting Oxygen Index	a
TI	Flammability Temperature Index	a
LU	London Underground	a

6.3 Definitions

The following topic specific definitions are created:

a) within London Underground's Glossary of Terms (1-622) (a Category 1 Standard);
b) from published sources that are clearly identified.

Term	Definition	Source
Smoke	Visible suspension in atmosphere of solid and/or liquid particles resulting from combustion or pyrolysis	b BS 4422-1
Technical liquids	Lubricants (including greases) and electrically insulating liquids, such as transformer oils and refrigerants.	A
Limited / dispersed materials	Where the mass is greater than 100g and less than 500g, and where there is a separation of not less than 0.5m between materials.	a
Extensive / grouped materials	Where the mass and separation exceed the definition of limited/dispersed materials.	A
Minor use materials	Where total mass and surface area do not exceed 100g or 0.2sqm respectively, regardless of separation between materials.	A

6.4 Technical content manager

Paragraph number	Technical content manager
All	Principle Fire Engineer

6.5 Document history

Issue no	Date	Changes	Author
2-01001-002 A1	December 2003	Standard E1042 A6, re-formatted and re-numbered to 2-01001-002,	Martin Weller
1-085 A1	March 2008	Re-written by LU in consultation with Infracos between July 2004 and July 2007	Martin Weller

Issue no	Date	Changes	Author
1-085 A2	December 2008	Clause 3.2.4.2 amended in line with outcome from the October 2007 Concessions Forum	Martin Weller
1-085 A3	March 2011	Update as per DRACCT 00274 – Correction of references to British and European Standards	Martin Weller

7 Current Written Notices attached to this standard

Written Notice No	Issue Date	Written Notice Title
LU-WN-01304	13/10/2014	Materials in retail units

Transport for London

London Underground

Written Notice	**LU Ref. No.:** LU-WN-01304
	Suppliers Ref. No.:

1	**Written Notice Completed By**	
	Person Accountable	Sam Sambasivan
	Directorate	Projects Directorate
	Date Issued	13/10/2014
2	**Details of the standard Requiring Clarification**	
	Title:	Fire Safety Performance of Materials
	Standard Reference No.	1-085
	Issue No.	A3
	Clause/Paragraph No.:	Clause 3.4.1, Paragraph (f)
3	**Details of Definitive LU Interpretation of Requirements**	
	Title of Written Notice	Materials in retail units

Clause 3.4.1, Paragraph (f), should read to include portable and fixed items within a retail unit as follows:

Retail stock, consumables, electrical equipment, furniture and personal effects (fixed and portable) kept within retail units where those units are fitted with fire detection and suppression systems and has a shop front which, when closed, has sufficient integrity to prevent the early spread of smoke. The shop front does not need to offer any particular period of fire resistance.