

BS 9992:2020



BSI Standards Publication

**Fire safety in the design, management
and use of rail infrastructure —
Code of practice**

bsi.

AVA Documents
Document Sharing Hub

Publishing and copyright information

The BSI copyright notice displayed in this document indicates when the document was last issued.

© The British Standards Institution 2020

Published by BSI Standards Limited 2020

ISBN 978 0 580 52282 6

ICS 13.220.01; 45.080

The following BSI references relate to the work on this document:

Committee reference FSH/14

Draft for comment 19/30370288 DC

Amendments/corrigenda issued since publication

Date	Text affected
------	---------------

Contents

	Page
Foreword	v
Section 1: General	1
0 Introduction	1
0.1 General principles	1
0.2 Approval, assurance and verification arrangements for railway works	3
1 Scope	4
2 Normative references	5
3 Terms and definitions	7
4 General recommendations and background	9
4.1 Basis of design	9
4.2 Property protection and business continuity	10
4.3 Mixed-use premises	10
4.4 Security	10
4.5 Stakeholder consultation workshop (SCW)	10
Section 2: Management of fire risk	14
5 General management procedures	14
6 Fire risk assessment	14
7 Emergency planning	14
8 Failure or non-availability of equipment	15
Section 3: Integrating management within fire safety design	17
9 Operational concept	17
10 Management input during the design process	18
10.1 General	18
10.2 Staffing levels	18
10.3 Management of tunnels	19
11 Trial operations and testing	19
12 Designing for the management of means of escape	20
Section 4: Designing means of escape	21
13 Principles of means of escape	21
14 Means of escape from areas of railway stations which have public access	21
14.1 Risk profile	21
14.2 Occupancy	21
14.3 Means of escape	22
14.4 Travel distances	23
14.5 Escape routes	23
14.6 Escape capacity	23
<i>Table 1 — Vertical and horizontal escape capacity</i>	24
<i>Table 2 — Escalator escape capacity</i>	24
<i>Table 3 — Pedestrian travel speeds</i>	24
14.7 Methodology to be used in calculating escape capacity	24
14.8 Platform sizes	26
15 Means of escape from non-public areas of stations	26
15.1 Risk profile	26
15.2 Occupancy	26
<i>Table 4 — BoH floor space factors</i>	26
15.3 Travel distances	26
15.4 Escape provisions	27
16 Means of escape for persons with restricted mobility (PRM)	28

16.1	Provision of accessible means of escape	28
16.2	Provision of refuges	28
16.3	Use of lifts for the evacuation of PRM	30
16.4	Fire protection of lifts and refuges	30
	Section 5: Access and facilities for firefighting	32
17	General recommendations for firefighting facilities	32
18	Firefighting shafts	33
18.1	Provision and siting of firefighting shafts	33
	<i>Table 5 — Provision of firefighting facilities</i>	34
	<i>Figure 1 — Example of fire main provision for a simple surface station</i>	35
	<i>Figure 2 — Split firefighting shaft for use when a continuous vertical shaft is not practicable</i>	36
18.2	Layout of firefighting shafts	37
18.3	Construction of firefighting shafts	38
18.4	Firefighters lifts	38
19	Vehicle access	39
20	Water supplies for fire and rescue service use	39
20.1	Fire mains	39
20.2	Emergency water supply tanks	41
21	Communications systems for fire and rescue service use	41
21.1	General	41
21.2	Tunnels, escape and intervention facilities	42
21.3	Fire control centres	42
22	Drawings for fire and rescue service use	43
23	Heat and smoke control	43
23.1	Smoke ventilation of firefighting shafts serving sub-surface railway infrastructure	43
23.2	Venting of smoke and heat from enclosed and sub-surface stations	43
24	Isolation and earthing of traction power	44
25	Access and facilities for specific types of railway buildings or infrastructure	44
25.1	Tunnels	44
	<i>Figure 3 — Location and spacing of fire main outlets/landing valves in tunnels</i>	47
25.2	Viaducts	48
25.3	Cuttings	48
	Section 6: Tunnels and viaducts	50
26	General recommendations for tunnels and viaducts	50
26.1	Tunnel design	50
26.2	Operational principles	50
27	Ventilation and smoke control systems	52
27.1	General	52
27.2	Single-track tunnels	52
27.3	Multi-track tunnels	52
27.4	Ventilation zones	53
27.5	Ventilation design criteria	53
28	Means of escape from tunnels and viaducts	55
28.1	General	55
28.2	Tunnel and viaduct walkways	56
28.3	Tunnel and viaduct signage	56
28.4	Tunnel escape facilities and shafts	56
28.5	Tunnel cross-passages	57
28.6	Tunnel emergency lighting	57
28.7	Tunnel fire detection and fire alarm systems	58

29	Tunnel and viaduct fire resistance	58
	Section 7: Railway train care and maintenance buildings	60
30	General recommendations for railway train care and maintenance buildings	60
31	Risk profile	60
	<i>Table 6 — Fire growth rate category examples</i>	60
32	Means of escape from train care depots and enclosed maintenance buildings	61
	Section 8: Signalling control and electrical control centres	62
33	Control centre facilities	62
33.1	Fire and rescue service access	62
33.2	Emergency and standby lighting	62
33.3	Communications	62
33.4	Control room equipment	62
34	Design and construction of control centres	63
34.1	Fire protection strategy	63
34.2	Means of escape	64
34.3	Fire separation	64
34.4	Separation and construction of electronic equipment areas	64
34.5	Ventilation systems	64
	Section 9: Reaction to fire (materials and finishes)	65
35	Surface locations	65
36	Sub-surface locations	65
36.1	Sprinkler-protected sub-surface stations	65
36.2	Non-sprinkler-protected sub-surface stations and tunnels	65
	<i>Table 7 — Reaction to fire properties in non-sprinkler-protected sub-surface stations and tunnels</i>	66
36.3	Other sub-surface locations	67
37	Enclosed locations	67
	<i>Table 8 — Reaction-to-fire properties in enclosed stations</i>	67
	Section 10: Fire safety during construction	68
38	Construction planning	68
38.1	General	68
38.2	Fire risk assessment	69
38.3	Liaison with enforcing authorities and the emergency services	70
38.4	Emergency planning	71
38.5	Emergency services communications	73
39	Means of escape during construction	74
39.1	General	74
39.2	Fire warning systems	75
40	Fire protection measures	76
40.1	Fire separation and compartmentation	76
40.2	Temporary protective floor and wall coverings	77
40.3	External hoarding	77
40.4	Construction materials delivered to the site	77
40.5	Routine testing and maintenance of fire protection equipment	77
40.6	Temporary tunnel ventilation systems	77
40.7	Fire safety signage	78
41	Facilities for firefighting during construction	78
41.1	Water supplies for firefighting	78
41.2	Portable firefighting equipment	80
41.3	Plant and vehicle fire suppression	80
42	Use of acetylene below ground	80

	Section 11: Fire safety systems design	82
43	General recommendations for fire safety systems design	82
44	Passive fire protection	82
44.1	General	82
44.2	Fire resistance	83
44.3	Openings	83
45	Fire detection and fire alarm	84
45.1	General	84
45.2	Equipment selection	85
45.3	Cause and effects	86
45.4	Notification of fire in rooms accessed only via tunnels	86
45.5	Fault reporting	87
46	Fire suppression and extinguishing systems	87
46.1	Life safety	87
46.2	Business continuity	87
	<i>Figure 4 — Business continuity decision-making process</i>	88
47	Emergency lighting	88
48	Station smoke control	89
49	Emergency signage and fire safety notices	90
Annex A	(informative) Worked examples for calculating platform and station clearance times	91
	<i>Figure A.1 — Island platform</i>	93
	<i>Table A.1 — Data for island platform example — Travel times</i>	93
	<i>Table A.2 — Data for island platform example — Egress capacity</i>	94
	<i>Figure A.2 — Side platform</i>	96
	<i>Table A.3 — Data for side platform example — Travel times</i>	97
	<i>Table A.4 — Data for side platform example — Egress capacity</i>	97
Annex B	(informative) Firefighters lifts access and BS EN 81-72 compliance	100
Annex C	(informative) Modelling the movement of products of combustion in tunnels	101
Annex D	(normative) Railway train care and maintenance buildings	103
	<i>Table D.1 — Maximum travel distances for railway train care and maintenance buildings with minimum package of fire protection measures</i>	105
Annex E	(informative) METHANE model for incident reporting	107
	<i>Figure E.1 — The METHANE model</i>	107
	Bibliography	108

Summary of pages

This document comprises a front cover, and inside front cover, pages i to vi, pages 1 to 109, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 April 2020. It was prepared by Technical Committee FSH/14, *Fire precautions in buildings*. A list of organizations represented on this committee can be obtained on request to its secretary.

Relationship with other publications

The British Standard is intended to be read in conjunction with [BS 9999:2017](#).

Information about this document

The British Standard is intended to be used by:

- railway owners, operators and infrastructure managers;
- train operating companies (TOCs) – safety managers, station and tunnel managers and engineers;
- design houses (single and multi-disciplinary) – project managers, project engineers and fire safety engineers;
- architects of railway infrastructure;
- building and construction contractors;
- system design contractors (engineers);
- suppliers and installers of fire protection systems in railway infrastructure (fire detection and fire alarm systems, fire suppression and extinguishing systems, smoke control, pressurization and extract systems, fire-resisting structures and separating elements, materials with fire performance requirements);
- regulators; and
- maintainers.

This British Standard provides recommendations and guidance on the provision of measures to control or mitigate the effects of fire. The primary objective is to ensure that an adequate standard of life safety can be achieved in the event of fire in the premises. A secondary objective is to provide a level of protection for property, the operation of the railway and businesses against the impact of fire, e.g. in close proximity to other premises or as part of the same premises or complex. These objectives can also have the effect of assisting the fire and rescue service and/or of providing environmental protection.

There are references throughout this British Standard to occupant safety, firefighter safety, and business and property protection, to draw attention to the different issues these could raise. It is, however, important to be aware that provisions solely for life safety are unlikely to provide the full level of protection for buildings and property in a fully developed fire scenario.

This British Standard complements [BS 9999](#) and varies from it only where appropriate to support the particular ways in which railway infrastructure is constructed or operated. Where recommendations are not explicitly included, then the default is that [BS 9999](#) be referred to for relevant guidance.

A fire safety engineering approach as detailed in [BS 7974](#) might be more appropriate in the design of some complex railway premises.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

Where websites and webpages have been cited, they are provided for ease of reference and are correct at the time of publication. The location of a webpage or website, or its contents, cannot be guaranteed.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

Contractual and legal considerations

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

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

Section 1: General

0 Introduction

0.1 General principles

The design of acceptable fire safe railway infrastructure relies upon an understanding of the causes of fire, the materials and systems likely to be involved in fire, human behaviour in fire emergencies, firefighting tactics and the likely spread of fire.

The recommendations and guidance given in this British Standard are based on the assumption that under normal circumstances, a fire is unlikely to start in two different places in a premises.

Whilst certain parts of railway premises lend themselves to being designed in accordance with published guidance for general buildings, the parts of those premises provided for the transit of trains (e.g. tunnels) and the public areas of stations might not. The reasons for this include the following.

- Tunnels offer unique fire safety challenges; they are very often deep underground, with firefighting access and escape distances far greater than those generally recommended for buildings. It is not usually practicable to build shafts or tunnels which would bring those distances into compliance with the guidance for general buildings.
- The design of railway rolling stock is addressed in the [BS EN 45545](#) series of standards; these are based upon certain assumptions about the configuration of tunnels and the fire protection arrangements in them. The treatment of safety in these premises therefore addresses the combined fire protection characteristics of rolling stock and tunnel infrastructure as a single safety system, hence it is important that the fire protection arrangements in tunnels follow the established approach applied to those structures, rather than the standards applied to buildings.
- Railway stations can be regarded, on the whole, as mechanisms for transporting railway passengers from the street to the platforms and onto the trains (and in the opposite direction) efficiently and safely. For the most part, they are designed to cope with a transient population whose time occupying the premises might last no more than a few tens of minutes (although this is not always the case; see Note 1). For this reason, the public areas of stations are often designed with few facilities for comfort, and the fire load permanently present in the public area can usually be restricted so that it is minimal. In addition, travel distances greater than those accepted in other types of buildings can often be safely accommodated.

NOTE 1 Railway stations often incorporate other uses, such as retail, assembly and recreation, which are accessible from station concourses.

- The operational response to a fire on a train is often to bring it into the next available station, if possible, as it is normally from these locations where means of escape can happen most swiftly, and firefighting access can be most effectively accommodated. It is foreseeable, therefore, that buildings which are almost always lightly occupied might suddenly have to accommodate several thousand occupants concurrently with a significant fire [the train(s) carrying those people], rather than their usual level of patronage. Station designs might have to cater for this scenario, which is not usually faced in other premises.
- Sub-surface stations can be deep underground, and the platforms can be vertically displaced far from the surface structures, often under roadways or other buildings. Guidance on basements in other buildings, which are typically directly underneath the buildings they serve, can be difficult to apply.

NOTE 2 Attention is drawn to the Fire Precautions (Sub-surface Railway Stations) Regulations 1989 [1], and to the Fire Precautions (Sub-surface Railway Stations) (England) Regulations 2009 [2].

- The availability of railway infrastructure can be critical to the normal functioning of a town, city or other transport infrastructure (e.g. an airport). The complete or partial loss of the railway service might necessitate the increased use of other transport modes, which generally do not offer the same capacity as railways. It can affect the daily lives of tens of thousands of people, perhaps causing them to use less safe forms of transport. It can, therefore, be particularly important to establish whether fire protection measures beyond those strictly required for life safety in the premises need to be provided.

The recommendations in this British Standard apply to both existing and new premises, but existing structures, especially historic ones, can offer challenges which are unlikely to arise in new construction. In sub-surface infrastructure, in particular, the cost of driving new tunnels or shafts to improve means of escape and firefighting access is so great that it is not usually practicable unless as part of major works to reconfigure or rebuild the infrastructure. In the case of some surface infrastructure, there can be significant constraints caused by the proximity of existing buildings, or the permanent way itself. The application of this British Standard, in its entirety, might not, therefore, be reasonably practicable for such premises. It is therefore particularly important that, in such cases, the stakeholders are consulted prior to the design being finalized and the works commencing. This helps to ensure that the scope of the fire safety-related works and the standards used are appropriate in the circumstances, and that any significant variations from the recommendations in this British Standard are justified. The stakeholder consultation workshop (see 4.5) offers a means to help establish that consensus.

In assessing the fire safety management needs of an existing building which is being modified, it is essential to have a full understanding of the existing structure and any fire safety provisions incorporated, and to take into account all of the following:

- a) any change in use of the premises which could affect the fire risk profile (e.g. changes in passenger numbers due to revised service patterns or new rolling stock);
- b) how the necessary fire safety levels can be practicably achieved in the existing premises;
- c) historic and conservation aspects of the premises and to what extent they need to be preserved;

NOTE 3 The conservation of historic building fabric alone is insufficient justification for accepting levels of safety lower than those that would otherwise apply. It can, however, affect which of several options for achieving the same level of safety is chosen.

- d) legislation and guidance introduced since the premises were originally constructed or last altered, or since their fire safety was last assessed;
- e) the interrelationship between life safety and measures to protect property/contents;
- f) systems integration;
- g) operational integration;
- h) business continuity; and
- i) asset protection.

Historic railway infrastructure presents particular challenges, as it might be listed, and permitted material alterations are therefore limited without the agreement of the appropriate authorities. For such premises, it can be advisable to seek the advice of consultative bodies, such as Historic England, Cadw, Historic Scotland and the Northern Ireland Environment Agency, in the early stages of design. The appropriate authorities sometimes agree to modifications to improve life safety where, in turn, there will be added long-term protection and preservation of the original building fabric. In some

cases, the railway operator or infrastructure manager might have specialists who manage their relationship with the conservation authorities and who can be consulted to obtain advice.

The principles and recommendations in this British Standard apply straightforwardly where the premises have a single main use as railway infrastructure and are contained in a single, separate building. Complications might arise, however, where a building comprises two or more different main uses (such as retail facilities within or connected to a railway station, or office accommodation within the station). In such cases it is important to consider the effect of one risk on another. A fire in a shop or unattended office could have serious consequences for the railway. Similarly, a high fire risk in one part of a premises could seriously affect other areas in another part of that premises.

The following are factors that need to be taken into account in establishing a minimum package of fire protection measures:

- 1) the potential users of the building (staff, maintainers and members of the public);
- 2) the hazard posed by other occupancies or premises, including boundary conditions;
- 3) ignition sources, types and extent of fire loads, and available ventilation;
- 4) the provision for giving warning in the event of fire, including any automatic fire detection;
- 5) the provision of automatic fire suppression or extinguishing systems;
- 6) smoke clearance and smoke control arrangements;
- 7) the overall management and control of the premises, including staffing numbers and whether those vary throughout the period during which the premises are occupied;
- 8) structural fire protection and compartmentation;
- 9) the fire performance of the materials from which the premises will be constructed, both internally and externally;
- 10) firefighting access to the building (including for vehicles);
- 11) the facilities provided for firefighters;
- 12) fixed and portable firefighting equipment;
- 13) fire safety signage;
- 14) emergency lighting; and
- 15) the security of and access to the building and its effect on fire safety.

The inclusion of an item in this list does not necessarily mean that it is required in all premises, but all of these items need to be actively assessed when developing the package.

0.2 Approval, assurance and verification arrangements for railway works

Building works for railways might not be subject to third-party approval. The railway operators or infrastructure managers (the duty holders) might be able to self-approve even major construction work under safety case and safety certification arrangements that enable them to offer a railway service. For this reason, it is important that the approval and acceptance process for such works is clearly communicated to suppliers of both design services and the works themselves by the railway client(s) before the work of the suppliers commences, including information that specifically describes the arrangements pertinent to fire safety.

Under their safety certification arrangements, some duty holders might impose mandatory technical requirements, including their own internal technical standards or specifically referenced national guidance. The duty holder might require that any variation from those standards is subject to their specific and prior approval, before it is introduced on the operating railway. This might mean that

standards which would be regarded as guidance in other types of building become mandatory in railway-related works.

Some duty holders have specific requirements for the assurance and verification of fire safety-related railway works before accepting them into use, and these can be significantly more thorough than works of a similar nature for other types of premises. Where these requirements exist, the duty holder needs to ensure that they are communicated to those constructing, commissioning and delivering the works sufficiently early that the requirements can practicably be complied with. Where these arrangements require the endorsement of the safety and functionality of the works by fire safety specialists, it is advisable for those specialists to be appointed before any works involving assets that have a fire safety function commence on site. There needs to be continuity of such specialist surveillance throughout the life of the project, including appropriate arrangements for cooperation or handover if the appointment involves more than one person. The form of endorsement expected needs to be clearly defined by the duty holder, and the specialists need to be afforded sufficient authority over the conduct of the works that they can practicably deliver that assurance.

Where the works are being delivered by a number of suppliers then the duty holder needs to define how the interfaces between those delivery packages are to be managed, to deliver integrated railway infrastructure that is acceptably fire safe. For example, a line extension might involve several principal contractors delivering different pieces of infrastructure, or line-wide systems might involve a single contractor designing and installing equipment on a number of sites. All those involved in the works need to cooperate and coordinate those works so that fire safety is effectively managed.

1 Scope

This British Standard gives recommendations and guidance on the design, management and use of railway buildings and the permanent way to achieve reasonable standards of fire safety for all people in and around rail infrastructure (railways and guided systems).

It covers:

- stations (surface, sub-surface and enclosed);
- platforms;
- tunnels;
- viaducts;
- elevated rail;
- train care depots and maintenance facilities;
- training facilities;
- sidings;
- signalling/control facilities; and
- ancillary buildings.

This British Standard is primarily intended for life safety but also gives guidance on protection of property, business and operations.

This British Standard is applicable to the design of new premises, and to material alterations, extensions and material change of use of existing premises.

This British Standard does not cover fire safety of rolling stock, or fire safety design strategies for extreme events such as terrorist actions.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards references

[BS 336](#), *Specification for fire hose couplings and ancillary equipment*

[BS 3251](#), *Specification – Indicator plates for fire hydrants and emergency water supplies*

[BS 4142](#), *Methods for rating and assessing industrial and commercial sound*

[BS 5041-3](#), *Fire hydrant systems equipment – Part 3: Specification for inlet breechings for dry riser inlets*

[BS 5266-1](#), *Emergency lighting – Part 1: Code of practice for the emergency lighting of premises*

[BS 5306-3](#), *Fire extinguishing installations and equipment on premises – Part 3: Commissioning and maintenance of portable fire extinguishers – Code of practice*

[BS 5306-8](#), *Fire extinguishing installations and equipment on premises – Part 8: Selection and positioning of portable fire extinguishers – Code of practice*

[BS 5395-1](#), *Stairs – Part 1: Code of practice for the design of stairs with straight flights and winders*

[BS 5499-4](#), *Safety signs – Part 4: Code of practice for escape route signing*

[BS 5499-10](#), *Guidance for the selection and use of safety signs and fire safety notices*

[BS 5839-1:2017](#), *Fire detection and fire alarm systems for buildings – Part 1: Code of practice for design, installation, commissioning and maintenance of systems in non-domestic premises*

[BS 5839-8](#), *Fire detection and fire alarm systems for buildings – Part 8: Code of practice for the design, installation, commissioning and maintenance of voice alarm systems*

[BS 5839-9](#), *Fire detection and fire alarm systems for buildings – Part 9: Code of practice for the design, installation, commissioning and maintenance of emergency voice communication systems*

[BS 6164](#), *Health and safety in tunnelling in the construction industry – Code of practice*

[BS 6266](#), *Fire protection for electronic equipment installations – Code of practice*

[BS 7273-4](#), *Code of practice for the operation of fire protection measures – Part 4: Actuation of release mechanisms for doors*

[BS 8300-2](#), *Design of an accessible and inclusive built environment – Part 2: Buildings – Code of practice*

[BS 8489-1](#), *Fixed fire protection systems – Industrial and commercial watermist systems – Part 1: Code of practice for design and installation*

[BS 8519:2010](#), *Selection and installation of fire-resistant power and control cable systems for life safety and firefighting applications – Code of practice*

[BS 8591](#), *Remote centres receiving signals from alarm systems – Code of practice*

[BS 9990:2015](#), *Non-automatic firefighting systems in buildings – Code of practice*

[BS 9999:2017](#), *Fire safety in the design, management and use of buildings – Code of practice*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

BS EN 81-72:2015, *Safety rules for the construction and installation of lifts – Particular applications for passenger and goods passenger lifts – Part 72: Firefighters lifts*²⁾

BS EN 115-1, *Safety of escalators and moving walks – Part 1: Construction and installation*

BS EN 1992-1-2, *Eurocode 2 – Design of concrete structures – Part 1-2: General rules – Structural fire design*

[BS EN 12101](#) (all parts), *Smoke and heat control systems*³⁾

BS EN 12845, *Fixed firefighting systems – Automatic sprinkler systems – Design, installation and maintenance*

[BS EN 13501-1:2018](#), *Fire classification of construction products and building elements – Part 1: Classification using data from reaction to fire tests*

[BS EN 13501-2:2016](#), *Fire classification of construction products and building elements – Part 2: Classification using data from fire resistance tests, excluding ventilation services*

[BS EN 13501-6:2018](#), *Fire classification of construction products and building elements – Part 6: Classification using data from reaction to fire tests on power, control and communication cables*

BS EN 15663, *Railway applications – Vehicle reference mass*

BS EN 16034, *Pedestrian doorsets, industrial, commercial, garage doors and openable windows – Product standard, performance characteristics – Fire resisting and/or smoke control characteristics*

BS EN 16191, *Tunnelling machinery – Safety requirements*

BS EN 45545-2:2013+A1:2015, *Railway applications – Fire protection on railway vehicles*⁴⁾

[BS EN 50305:2020](#), *Railway applications – Railway rolling stock cables having special fire performance – Test methods*

BS EN IEC 60332-3-24:2018, *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 IEC 60332-3-25:2018, *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 61034-2:2005+A2:2020, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

BS EN 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

BS EN ISO 7010, *Graphical symbols – Safety colours and safety signs – Registered safety signs*

[BS EN ISO 7243](#), *Ergonomics of the thermal environment – Assessment of heat stress using the WBGT (wet bulb globe temperature) index*

BS EN ISO 12922, *Lubricants, industrial oils and related products (class L) – Family H (Hydraulic systems) – Specifications for hydraulic fluids in categories HFAE, HFAS, HFB, HFC, HFDR and HFDU*

BS ISO 3864-1, *Graphical symbols – Safety colours and safety signs – Part 1: Design principles for safety signs and safety markings*

ISO 834-1, *Fire resistance tests – Elements of building construction – Part 1: General requirements*

²⁾ This British Standard also gives an informative reference to the complete BS EN 81 series.

³⁾ This British Standard gives specific references to BS EN 12101-6:2005.

⁴⁾ This British Standard also gives an informative reference to the complete [BS EN 45545](#) series.

Other publications

[N1] RAIL SAFETY AND STANDARDS BOARD LTD. *Lineside operational safety signs*. GI/RT7033. Issue 3. London: RSSB, 2015.

[N2] FIRE PROTECTION ASSOCIATION. *Fire prevention on construction sites: The Joint Code of Practice*. 9th edition. Gloucestershire: FPA, 2018.

[N3] GREAT BRITAIN. *Fire safety in construction: Guidance for clients, designers and those managing and carrying out construction work involving significant fire risks*. HSG 168. Second edition. London: HSG, 2010.

[N4] LOSS PREVENTION CERTIFICATION BOARD. *Requirements for the LPCB approval and listing for fire performance of temporary protective covering materials for use in the interior of buildings*. LPS 1207. Issue 3.1. Watford: BRE Global, 2014. London: RSSB, 2013.

[N5] LOSS PREVENTION CERTIFICATION BOARD. *Flammability requirements and tests for LPCB approval of scaffold cladding materials*. LPS 1215. Issue 2. Watford: Loss Prevention Certification Board, 1998.

[N6] RAIL SAFETY AND STANDARDS BOARD LTD. *Railway industry standard for lighting at railway stations*. RIS-7702. London: RSSB, 2013.

3 Terms and definitions

For the purposes of this British Standard the following definitions apply.

3.1 ancillary accommodation

all parts of a railway station that are ancillary to the main use of the station and under the control of the management of the overall premises

3.2 competent person

person, suitably trained and qualified by knowledge and practical experience, and provided with the necessary instructions, to enable the required task(s) to be carried out correctly

[SOURCE: BS 9999:2017, 3.23]

3.3 duty holder

entity that holds responsibility, under the railway's formal safety management arrangements, for fire safety in the construction and/or operation of the relevant railway infrastructure

NOTE There might be different or multiple duty holders, according to the activity or operation being considered.

3.4 fire and rescue service access level

level at which fire and rescue service vehicles have access and from which there is suitable entry to a building

NOTE 1 This level also gives access to a firefighting shaft and firefighters lift, where provided, and is the level to which the firefighters lift car returns when the firefighters lift switch is operated or a fire alarm is activated.

NOTE 2 Where more than one firefighters lift is provided within a large or complex building, there might be more than one fire and rescue service access level.

[SOURCE: BS 9999:2017, 3.35]

3.5 fire safety manager

nominated person carrying out the job of management of fire safety

[SOURCE: BS 9999:2017, 3.49]

3.6 forward ventilation

ventilation with the air flowing in the same direction as a train was moving in normal service prior to any incident

3.7 front of a train

any point forward of the middle point of a train

3.8 grade level

level at which the ground surface meets a building or the top of its foundation

NOTE This is not necessarily the same as street level exit. It is sometimes referred to as “at-grade”.

3.9 permanent way

guidance and support system for rail vehicles

NOTE This includes rails, buffer stops, rail supports and rail fastenings, and can also include sleepers and ballast.

3.10 persons with reduced mobility (PRM)

persons who have a permanent or temporary physical, mental, intellectual or sensory impairment which, in interaction with various barriers, might hinder their full and effective use of transport on an equal basis with other passengers

NOTE This definition does not apply to persons who are hindered solely by having oversized items (e.g. bicycles and bulky luggage).

3.11 place of relative safety

place in which there is no immediate danger, but in which there could be future danger, from the effects of a fire

[SOURCE: BS 9999:2017, 3.89]

3.12 place of ultimate safety

place in which there is no immediate or future danger from fire or from the effects of a fire

NOTE For occupants evacuating from railway infrastructure, this could be either:

- *a public space at a safe location outside the station, permanent way or rail vehicle; or*
- *a point at grade level at a safe location beyond the enclosing station or rail building or trackway.*

[SOURCE: BS 9999:2017, 3.91, modified – note added]

3.13 platform

area usable by passengers in a station, parallel to the permanent way, that provides direct, level access to trains

3.14 platform exit

position where persons can leave a platform

3.15 pre-charged fire main

type of fire main permanently filled with water in order to reduce the time required for the fire and rescue service to fill and pressurize the main

NOTE This type of main is used by the fire and rescue services in the same manner as a dry fire main.

3.16 protected

enclosed (other than any part which is an external wall of a building) with fire-resisting construction

[SOURCE: BS 9999:2017, 3.95]

3.17 protected route

route that is provided with means to ensure that persons escaping are protected from the harmful effects of fire, and that leads to a place of ultimate safety

3.18 reverse ventilation

ventilation with the air flowing in the opposite direction to which a train was moving in normal service prior to any incident

3.19 stations

3.19.1 enclosed station

station where at least one platform accessible to the public and any part of its associated permanent way is covered by a roof, building, bridge or tunnel continuously for over 50 m

3.19.2 sub-surface station

enclosed station where the roof or ceiling immediately above the platform and its permanent way is below the level of the ground adjacent to any station exit used as a means of escape in the event of fire, and where there is at least one platform accessible to the public and its adjacent permanent way that is covered by a building, bridge or tunnel for at least 50% of its length

3.19.3 surface station

station that is not an enclosed station or a sub-surface station

3.20 ventilation zone

section of tunnel between two ventilation shafts or between a ventilation shaft and a portal

3.21 viaduct

railway elevated above grade and supported by columns or arches

NOTE For the purposes of this British Standard, this term covers all railway bridges.

4 General recommendations and background

4.1 Basis of design

The background information given in [BS 9999:2017](#), Clause 4, should be taken into account, and the general recommendations met, where applicable to railway infrastructure premises and facilities. Where the recommendations in [BS 9999:2017](#) are modified or augmented in the present standard, the latter should take precedence.

4.2 Property protection and business continuity

The recommendations for property protection and business continuity in [BS 9999:2017](#), Annex A should be met during the design process, to limit damage to the infrastructure and to reduce the impact on performance during a fire.

NOTE When determining the requirements for property protection/business continuity, it is advisable to consult the duty holder, the client (if different to the duty holder) and/or any insurers who have an interest in the relevant infrastructure.

4.3 Mixed-use premises

Facilities that are independent of a railway station and separated from it by fire-resisting construction (e.g. retail premises, office space or training facilities) should be in accordance with the relevant annexes in [BS 9999:2017](#).

Ancillary accommodation within railway stations (e.g. retail units) should be designed as part of the railway station.

Control centres should be in accordance with [Section 8](#) of the present standard.

In all cases, railway premises should be designed and constructed such that they are able to operate independently from the non-railway parts of the premises, both in normal use and in a fire emergency.

4.4 Security

COMMENTARY ON 4.4

Security (in terms of the safety of occupants, rather than revenue protection) and fire safety might be viewed as being in conflict during the design process, but they are equally important, and one does not take precedence over the other. Designs need to accommodate both, so far as is reasonably practicable.

The need for security should be assessed at an early stage in the design process, and appropriate provisions put in place.

NOTE 1 Large signalling and control centres require a high level of security provision around their perimeters.

In order to determine the appropriate provisions, and to ensure that such provisions are compatible with the fire safety design requirements, the designer should consult any security specialist employed by the duty holder, and the relevant police authorities.

NOTE 2 This is typically facilitated by the duty holder, who is likely to have a working relationship with the police and security services.

Where security measures could affect fire and rescue service access, the relevant fire and rescue service(s) should be consulted at an early stage of design.

4.5 Stakeholder consultation workshop (SCW)

COMMENTARY ON 4.5

The stakeholder consultation workshop (SCW) is a meeting that seeks to establish an agreed scope for the fire protection works, and an agreed set of design standards and requirements. [This is not the same as a qualitative design review (QDR) as defined in [BS 7974](#).]

The effectiveness of the SCW can be enhanced by preparing the following items in advance:

- a) a presentation describing the history, context, purpose and scope of the works;*
- b) drawings/diagrams showing the planned works in their finished state;*
- c) for existing premises, drawings/diagrams showing their configuration before the works commence (so that comparisons can be drawn);*

- d) if interim works are to be discussed, drawings showing these works, showing clearly the key differences in configuration at each stage;
- e) 3D/axonometric representations where these might aid comprehension for those not intimately familiar with the premises in question;
- f) the fire emergency plan for the premises, for existing premises where such a document exists;
- g) a list of the standards expected to be applied to the works; and
- h) a structured agenda that covers the items listed in [4.5.3](#).

The aim is to provide certainty for all parties that, so long as these agreements are honoured, any subsequent acceptance or approval can be relied upon. Varying the agreements made is usually possible only with the consent of all the essential stakeholders, and it might require re-constitution of the SCW.

4.5.1 General

The scope of the fire protection works and fire safety technical requirements for a project should be established at an early stage. This should be achieved by means of a stakeholder consultation workshop (SCW).

NOTE 1 In establishing the scope and technical requirements, the SCW can also reduce project risk, e.g. by minimizing the possibility of unwanted scope expansion or of constructing works that are not acceptable to the stakeholders.

NOTE 2 If a fire strategy has been prepared, it is often useful for this to have been distributed at least ten working days before the meeting, so that the attendees have had the opportunity to review it. If this has been done, the strategy can (if time permits) be reviewed at the meeting to determine whether it lists the correct standards and demonstrates appropriate levels of compliance. It is rarely useful for copies of fire strategies to be tabled at the meeting itself.

The meeting minutes are the main output from the SCW, and in order for these to be both comprehensive and useful, contemporaneous notes should be taken of the key items discussed and, for each item, the key agreements reached between the stakeholders; any disagreements; actions, responsibilities and deadlines. The minutes should be presented to the SCW team for acceptance, with an opportunity to correct them, before the team disbands. Once agreed by all stakeholders, the minutes of the SCW should be appended to the fire strategy document when this is created.

NOTE 3 Due to the technical nature of these meetings it is helpful if the note-taker has competence in the matters being discussed, so that they can identify the matters that need to be recorded and are able to effectively summarize the discussions.

4.5.2 Constitution and conduct of the SCW

The SCW is an important meeting and this should be reflected in its organization, the invitees, the preparation undertaken and the recording of its outcomes.

The following stakeholders should be invited to attend or be represented in order for the SCW to take place:

- a) the design team, including their fire engineer(s);
- b) a person able to describe the purpose and scope of the project;
- c) the sponsor/budget holder for the works;
- d) the operator/manager of the premises;
- e) the project manager;
- f) the client;

- g) the regulator who will accept the safety of the works (the arrangements for this are normally defined in the safety certification arrangements for the railway); and
- h) the relevant fire authority (or authorities, if the works span multiple jurisdictions).

NOTE 1 In some cases, a single attendee might be able to fulfil more than one role. It might also be appropriate for more than one individual with the same capabilities or role to attend (e.g. if there are multiple operators). Other stakeholders can be identified as required by the works.

If any of the stakeholders cannot attend or be appropriately represented, it should be determined whether it would be better to cancel or reschedule the meeting, as the lack of involvement of any one stakeholder could severely compromise the integrity of any decisions taken or agreements made.

Those present should between them be familiar with and able to describe:

- 1) the proposed scope of works;
- 2) the outline programme;
- 3) how the premises is/will be operated; and
- 4) what the existing and planned provisions for fire protection are and why the designers determined that these are acceptable.

The SCW should be chaired by an agreed competent person, who should be neither the designer of the works nor the regulator to whom they are to be assured (these have a separate role that would normally preclude them being an effective and independent Chair). The Chair should not be directly involved in the works at any time (past, present and future), though they may come from the design organization if they are independent of the design team.

The Chair should make every effort to conduct the meeting such that all the matters listed in [4.5.3](#) are discussed and, if possible, the fire safety requirements agreed.

NOTE 2 If agreement cannot be reached at the SCW, it is not normally possible to escalate the issue via an individual organization as no single stakeholder has the authority to overrule all the others. In these circumstances, it is typically the Chair who proposes a dispute resolution mechanism. Simultaneous escalation in all the stakeholders' organizations might be necessary in order to explore resolution. It would be appropriate to seek the view of those who have a formal safety regulatory function on matters where consensus cannot be reached.

4.5.3 Output from the SCW

The SCW should seek to establish consensus as to:

- a) the scope of the works;
- b) the standard(s) and specific requirements to which the fire protection arrangements for the premises will be designed (this can include standards mandated by the client or infrastructure manager);
- c) the standards to which the fire protection systems will conform, in particular for:
 - 1) means of escape in case of fire (including for PRM) and the potential need for any evacuation simulations;
 - 2) access and facilities for firefighters;
 - 3) means of giving warning in case of fire;
 - 4) fixed and portable firefighting equipment;
 - 5) automatic firefighting systems;
 - 6) reaction-to-fire properties of the construction materials used (both internal and external to the premises);

- 7) structural fire resistance;
 - 8) fire-resisting compartmentation and fire separation;
 - 9) normal and emergency lighting;
 - 10) fire safety signage;
 - 11) communications for use in a fire emergency;
 - 12) smoke control and smoke clearance systems, and the potential for any computational fluid dynamics (CFD) fire and smoke simulations;
 - 13) fire safety emergency management arrangements for the premises, including staffing levels;
 - 14) interfaces with attached, adjacent, or associated premises where they could be affected by a fire in the premises being discussed;
 - 15) the site boundary conditions, where these could affect fire safety; and
 - 16) security or revenue protection arrangements, where these could affect fire safety;
- d) the acceptance criteria, objectives and input parameters of any proposed quantitative analysis, including computational fluid dynamics (CFD) simulation.

The inclusion of an item in this list does not necessarily mean that it is required in all premises, but all of these items should be actively assessed during the SCW, and included in the scope and technical requirements where the assessment shows this to be appropriate.

Section 2: Management of fire risk

5 General management procedures

Designing a premises to enable the management of fire risk, and the management of fire risks in occupied premises, should be in accordance with [BS 9999:2017](#), Section 4 and Section 9 respectively.

Operational procedures for the management of fire and other emergency incidents should be available for all railway premises. Where the premises are yet to be built, a draft or outline plan/procedure should be prepared by the duty holder, so that the designers can refer to it when preparing their designs.

The fire safety manager should define the organization's fire risk management system and methods of implementing the overarching policy within a fire risk management strategy.

6 Fire risk assessment

A fire risk assessment should be undertaken in accordance with [BS 9999:2017](#), 8.3.2.

NOTE 1 Attention is drawn to the Regulatory Reform (Fire Safety) Order 2005 [3] in respect of the need for responsible persons to make and maintain a fire risk assessment. Attention is also drawn to the Fire (Scotland) Act 2005 [4], the Fire Safety (Scotland) Regulations 2006 [5], and the Fire Safety Regulations (Northern Ireland) 2010 [6].

The risk assessment should be undertaken by a competent person.

NOTE 2 One way of demonstrating competency is to hold valid certification less than 5 years old from attending a fire risk assessors' course given by an accredited third-party certification body. Organizations might impose other qualification and experience criteria relative to their undertakings, including that of experience within the rail environment.

7 Emergency planning

For railway infrastructure, an emergency plan should be developed in accordance with [BS 9999:2017](#), 8.3.8.

NOTE 1 It can be advisable for the emergency plan to be developed taking into account joint emergency services interoperability principles (JESIP) [7] and UK fire and rescue service National Operational Guidance [8].

The emergency plan should contain contact details for all parties that might need to be reached during an emergency incident, including but not limited to emergency services, control centre, station manager and train operating company manager.

There should be a plan to cover specific incidents associated with the running of the railway, as well as for specific locations including stations, control centres and crew facilities.

Incident management roles and responsibilities should be clearly defined.

NOTE 2 Effective control is often achieved in the first few moments of any incident. Levels of control can be pre-determined to ensure appropriate timely responses.

The emergency plan should include a procedure for stopping services from calling at a station and alighting passengers whilst an emergency incident is in progress.

The emergency plan should also include a procedure for managing re-entry into the affected part of premises following a fire incident.

NOTE 3 Re-entry is usually not permitted until the required permissions have been given by the fire and rescue service.

NOTE 4 To discourage passengers from entering a station during a fire incident, an "Emergency Do Not Enter" sign can be affixed to station entrances.

NOTE 5 Facilities provided for use during a fire incident might also have a role in non-fire emergencies.

8 Failure or non-availability of equipment

An analysis should be undertaken to determine the minimum operating requirements for fire safety.

NOTE 1 In some circumstances, failures of systems and equipment might be accepted by operators, who might operate the railway at an increased level of risk for a short duration. The risk can be greater for parts of the railway reliant on multiple interdependent fire safety measures, e.g. stations and tunnels.

The operating requirements should take into account, as a minimum, which facets of the systems are required to be available and/or operational such that a reasonable level of safety can be provided at all times.

An analysis of minimum operating requirements should be performed as part of the design process in consultation with the infrastructure operators, infrastructure manager, the fire and rescue services and other stakeholders.

The determination of the minimum operational requirements should begin at the outset of the project and then be maintained throughout the project duration.

NOTE 2 The minimum operating requirements may be identified using a risk-based approach and can identify systems that might be acceptable as being unavailable for short durations. For example, it might be acceptable for a small number of emergency lighting fixtures to be unavailable for a short duration, but it is unlikely to be acceptable for an entire lighting system to be known to be non-operational during any train service.

The minimum operating requirements analysis should categorize types and extents of system failures, their modes, effects and criticality. It should define the maximum permissible duration for any failure beyond which it will be deemed that there is insufficient functionality for the infrastructure to remain open. It should also take into account the possibility of non-availability of multiple systems occurring at the same time.

The analysis of minimum operating requirements should follow common industry practice from both the rail industry and other transport modes as appropriate. It should take account of the frequency and severity of fire events, and societal aversion to low frequency but high consequence events.

Planning should include measures to address equipment and services failures, including:

- a) failure of any active fire system;
- b) failure of electricity supply;
- c) water supply failure; and
- d) failure of any passive fire provisions.

For each of these items, the possible impact of failure should be taken into account and mitigation measures planned accordingly.

NOTE 3 Mitigation measures could include procedures such as evacuating the premises, or providing additional personnel for monitoring purposes, until a failure is corrected.

Planning should also include a process for notifying the fire and rescue services of the failure or non-availability of any equipment that could affect the fire safety of the infrastructure or fire and rescue service operations. The method of notification and the categories of system failure or non-availability to be reported should be discussed with the relevant fire and rescue services.

Failure or non-availability of any device, or indication of a failure of any active or passive fire system, should be reported at the earliest opportunity to the railway fault reporting centre or to the designated service response organization. Any such failure should be minimized and actively managed.

Fire detection and fire alarm systems should not be compromised by the failure of any other connected system.

There should be a documented record available to all stakeholders to show the process of determining the minimum operating requirements, starting from the initial proposals, the outcomes of consultations, and the final requirements developed as a result. The procedure for managing the outcome of this process should also be part of the documentation.

The minimum operating requirements should be documented as part of normal railway operational procedures and made available to control room staff to support decision-making.

Section 3: Integrating management within fire safety design

COMMENTARY ON SECTION 3

The nature of railway facilities is such that their management requirements can vary enormously. Small, rural and seldom-used stations might require relatively little in the way of fire protection and routine fire safety management, whilst large stations in city centres can be complex both to design and to manage. The safe operation of tunnels can require sophisticated fire protection systems, constantly supervised by the railway operator. Given this variation, it is important that designers and fire engineers understand how any premises that they are designing are likely to be managed, and that any management-based assumptions made for design purposes are recorded and validated.

In some respects, railway facilities do not differ greatly from other types of building with similar occupancies, so many of the recommendations in [BS 9999:2017](#), Clause 10 apply equally to railway premises. One difference is that there is unlikely to be a fire safety manager for any single railway premises; it is more likely that the railway operator or infrastructure manager will retain one or more persons to perform that role covering all or part of the railway system.

Some railways are owned, operated, managed and maintained by the same organization; others split these responsibilities between different organizations with their respective responsibilities defined in contracts and safety management systems. It is particularly important in the latter case that the designers have a reasonable understanding of those arrangements, so that they can determine whom to consult on the various aspects of the design relevant to each entity.

Where existing railways (or railway lines) are being modified or renewed, there might be a well-defined operational structure and clarity surrounding the way in which the railway operator manages the facilities. There are likely to be fire and emergency management plans (for the premises in question, or for similar premises) that can be used to inform the designers how the premises will be managed in a fire emergency. In other cases – particularly for major infrastructure projects involving new lines – there might be no existing railway operator who can advise on such matters, so reasonable assumptions need to be made regarding the likely emergency management arrangements.

9 Operational concept

Prior to the design process commencing, the designer should obtain an operational concept for all facilities that are included within the works.

NOTE The operational concept is the basis of the design. It could inform, or be informed by, the SCW (see [4.5](#)), depending on when the SCW is undertaken.

The operational concept should include information regarding:

- a) the staffing arrangements for all periods where the premises are to be occupied (whether or not the public are present);
- b) the way in which the division of responsibilities will be configured, and the interfaces managed, where the facility is to be owned, managed, operated or maintained by different organizations;
- c) the type and configuration of rolling stock likely to be present (including non-passenger rolling stock, and potential for dangerous goods either travelling through or on stabled trains, where applicable), where it could influence the fire safety of the premises;
- d) the expected response of the train service to a fire incident, especially on railway lines other than the one containing a fire-affected train. If the design relies upon the train service being halted or

otherwise altered due to a fire emergency, then the time taken to complete reconfiguration of the service should be estimated conservatively;

- e) for train care depots and maintenance facilities, what work activities should be accommodated in those premises;
- f) for stations, an assumed maximum occupancy for the station, and sufficient information for the designers to determine the train load occupancy to be used in the means of escape calculations. Where the business case for a station or line relies upon predicted usage and/or occupancy figures, that same information should be used in the fire safety design;
- g) for tunnels, occupancy figures based upon the type and constitution of rolling stock that is expected to be present; and
- h) an outline (draft) emergency management plan that includes the fire safety management arrangements for both staff and passengers (including PRM).

Where the works relate to an existing railway operation, this information should be obtained from the relevant railway operator(s).

Where works are designed at a time when railway operators have yet to be appointed, or where the operators are likely to alter, the operational concept should be prepared by persons with relevant operational experience of similar railway undertakings, using reasonable assumptions where definitive information is not available. Where those assumptions could affect fire safety, they should be recorded within the operational concept documentation, so that they can be verified as valid by the relevant railway operator(s) once these are established.

10 Management input during the design process

10.1 General

Representatives from organizations responsible for the ownership and future management of the railway premises should, so far as possible, form part of the design team. This should include the fire safety manager for the owner and the railway operator, or their representatives. They should monitor the development of the design concept and the detail of the systems they will eventually have to manage. Where the design relies upon assumptions regarding how they will manage the premises, they should be asked to endorse those assumptions.

Where the railway operator knows who will maintain the fire protection and fire safety systems within the premises, the maintainers should be consulted during the design of those systems.

10.2 Staffing levels

COMMENTARY ON 10.2

Those railway facilities that are open to the public can have particularly challenging staff-to-occupant ratios in an emergency; a few personnel might have to manage the safe evacuation of hundreds or even thousands of passengers, many of whom are unfamiliar with the premises. Sometimes, in the event of a train fire, stations that are normally lightly used have to accommodate the entire population of that train. In the case of tunnels, the only staff likely to be present at the time a fire is discovered are those on board the train.

It is important to ensure that the fire safety design does not place unreasonable and unrealistic reliance on the number and capabilities of railway staff.

The railway operator (or their representatives) should conduct task analyses to determine the appropriate staffing levels for the facility being designed, i.e. the minimum number of staff who need to be present in order for the premises to be safely operated. This should allow for breaks, holidays,

sickness and any other potential absences where members of staff might not be available. For stations, this should not rely upon staff based in other locations.

Where the response to a fire emergency requires staff with defined levels of seniority, or of different competences/capabilities, then those should be clearly defined and incorporated in the total staff numbers.

In all cases these task analyses should be completed before the works commence.

The staffing analyses should take into account any need to meet and liaise with fire and rescue service personnel upon their arrival at an incident, as well as any requirement to inform those controlling the train service of the nature and location of the emergency.

NOTE For many fire emergencies, effective emergency services liaison requires the attendance of railway staff not normally present at that location.

The information on minimum staffing numbers should be recorded in the emergency plan for the premises.

10.3 Management of tunnels

COMMENTARY ON 10.3

Tunnels can be particularly complex, and their safe management relies on both railway staff present on the train, and personnel located in control centres that might be in remote locations. Swift and effective communication between on-board staff and the controllers usually has a vital part to play in the safe management of a fire emergency. General recommendations for tunnels are given in [Section 6](#).

Where tunnels are being designed, the emergency scenarios and operational responses that form the basis of the fire safety design should be developed in consultation with the railway and tunnel operator(s). Any assumptions made about the management of fire emergencies in the tunnel should not be relied upon unless they have been explicitly endorsed by those operators.

No safety proposal should be predicated on the response of the fire and rescue service.

11 Trial operations and testing

COMMENTARY ON CLAUSE 11

Railway facilities often undergo a period of trial operations prior to being opened to the public. During this period, the railway operators' staff might occupy the new or altered areas, and conduct tests and trials to ensure that the introduction into passenger service progresses smoothly. Railway staff might need to be present within the works at the same time as construction personnel, who might still be engaged on completion activities. This is often under arrangements where the railway staff are not expected to wear the same personal protective equipment as construction personnel; the railway staff might also not be used to working in a construction environment.

Where trial operations and testing are planned prior to a facility (or part of that facility) being opened to the public, all fire safety systems and fire protection serving those locations occupied by railway staff should be verified as being safe, functional and complete before access is offered. Emergency management plans should be prepared to describe how the evacuation of those personnel will be safely managed in the event of a fire emergency.

The railway operators' staff should be given the opportunity to test emergency management plans and procedures for:

- a) the evacuation of staff during trial operations and testing and prior to completion of the facility; and

- b) the evacuation of staff and members of the public when the railway facilities are open to the public.

NOTE 1 The response of members of the public to a “live” evacuation drill/exercise is likely to differ from conditions simulated when members of the public are not present.

Liaison should be undertaken with the relevant fire and rescue services prior to a facility being opened to the public, in order to inform them of trains that are expected to use the infrastructure during trial operations and of the proposed date for commencement of services, and to provide an opportunity for fire and rescue service personnel to undertake familiarization visits and update pre-incident plans.

NOTE 2 Further information on liaison with the fire and rescue services is given in [Section 5](#) and [Section 10](#).

12 Designing for the management of means of escape

The design team should identify any aspects of the design which will rely upon management, and the management objectives and requirements should be clearly stated.

Where the design relies upon pauses in the evacuation sequence, where any occupants are expected to wait for assistance in defined locations within the premises (e.g. within refuges or while waiting for an evacuation lift or a rescue train), it should be established that those locations are acceptably safe from all reasonably foreseeable fire risks for the entire period when they are expected to be occupied. Their onward route off the premises should be similarly protected from fire risk. The managers of the premises should be consulted to verify that any such locations are acceptably safe with regard to other types of hazard and risk (e.g. slips, trips, falls, touching exposed current-carrying conductors, or contact with moving trains).

Evacuation procedures for PRM at existing stations which do not have step-free access from platform level to a place of ultimate safety should take into account the needs of PRM who might be evacuating from a train on fire or from other trains expected to call at the station.

Section 4: Designing means of escape

NOTE The importance of management in relation to all aspects of escape is covered in [BS 9999:2017](#), Section 9.

13 Principles of means of escape

The expected reaction and subsequent actions of those responsible for the management of the building should be assessed against the development of the fire threat and time, and the provision of adequate means of escape should be determined accordingly, in accordance with [BS 9999:2017](#), Clause 11.

Means of escape should be designed in accordance with [BS 9999:2017](#), Section 5, together with the recommendations given in [Clause 14](#) to [Clause 16](#) of the present standard, which are specific to aspects of railway buildings infrastructure. The design should include explicit provisions for means of escape for all occupants, including PRM. As a general principle, the design should be based on an assumption that all occupants, including PRM, will be able to self-evacuate.

Means of escape from tunnels and viaducts should be designed in accordance with [Clause 28](#) of the present standard.

14 Means of escape from areas of railway stations which have public access

NOTE These areas include, but are not limited to, concourses, platforms, passenger interchange facilities, and ancillary use areas including retail and welfare facilities.

14.1 Risk profile

The risk profile for the public areas should be established in accordance with [BS 9999:2017](#), Table 4.

NOTE 1 It is important that the correct profile is established, taking into account the occupancy characteristics and fire growth rates. In public areas, occupants are awake, but users of the premises (passengers), including regular users, are unlikely to be familiar with alternative evacuation routes/provisions.

The fire growth rate should be established in relation to the location and the hazards that can be present.

NOTE 2 The growth rate of fires can vary for platforms where train vehicles could be present, compared to open concourses where baggage could be the main potential source of fire.

Where sprinkler systems (or watermist systems, where relevant fire test protocols exist) are installed, the risk profile in [BS 9999:2017](#), Clause 6 may be reduced by one level subject to the restrictions in [BS 9999:2017](#), 6.5.

Where only part of a building is provided with sprinklers, the reduction in risk profile applies only to the sprinklered area, as stated in [BS 9999:2017](#), 6.5. In such cases, the sprinklered and non-sprinklered locations should be separated by construction with a minimum classification of EI 60 in accordance with [BS EN 13501-2:2016](#).

14.2 Occupancy

The occupancy for areas where public have access should be established, taking into account existing and predicted transport usage with a suitable margin for any predicted growth, as agreed with stakeholders. Where the business case for the works relies upon predictions of increased patronage, then those same predictions should be used to determine passenger occupancy for fire safety purposes.

Occupancy within the public areas of the station for a peak period should be used to determine the means of escape capacity required to achieve the prescribed evacuation times for each evacuation scenario. This should include:

- a) passengers boarding trains (i.e. those passengers within the public areas of stations waiting to board trains); and
- b) passengers alighting from trains.

The peak period should be determined specifically for the station and should account for the busiest 1 h period at the station (i.e. largest number of boarders and alighters in any 1 h period). During this 1 h peak period the occupancy can vary, and the maximum potential occupancy for an incident should be established.

The peak-period demand should be based on passenger data for the station, where it exists. In the absence of this, data on passenger usage for the station should be established through a passenger footfall agreed with the stakeholders, or an origin and destination study.

For station(s) servicing areas such as sports stadia, exhibition centres or other special event locations, the peak ridership figures should include event loads not included in normal passenger loads.

Stations which are regularly used for access to events should be designed to cater for the foreseeable increase in occupancy caused by an event. Management controls can play a significant part in limiting the station occupancy during event times, but the means of escape from the station should still take into account the maximum occupancy anticipated.

Where a station provides retail outlets, and the potential for the retail outlets to form a destination instead of or in addition to the railway services, the additional occupancy should be calculated in accordance with [BS 9999:2017](#), 16.2.

14.3 Means of escape

NOTE For viaducts, the access walkway provided for the fire and rescue service (see [Section 5](#)) can be used as a means of escape.

Public areas in stations that could be impacted by a fire incident should normally be designed to be evacuated simultaneously, which is the typical and suitable approach for most stations.

Designers should, however, take the following issues into account to determine whether an alternative approach would be more appropriate:

- a) remoteness from the incident for other operational station areas;
- b) the possibility of fires within retail premises that do not rely on evacuation through public areas; and
- c) means to provide fire separation between different occupancies/premises in accordance with [BS 9999:2017](#), Section 7.

If progressive evacuation is deemed to be suitable, the fire safety provisions should be such that occupants are not affected by fire and smoke.

For a station, the design of the means of escape should be based on both an emergency condition on a train [requiring evacuation of the train(s) and station occupants] and a fire within the station premises, although it is not assumed that both scenarios occur simultaneously.

If platform edge doors are installed, there should be a means for passengers to open them manually in the event of an emergency from the vehicle side if they have failed to open or there has been a misalignment of the vehicle doors to the platform.

14.4 Travel distances

14.4.1 Enclosed and sub-surface stations

Travel distances for enclosed and sub-surface stations, with the exception of the platform, should meet the recommendations given in [BS 9999:2017](#), Table 11 for the appropriate risk profile.

There should be at least two exits from an enclosed or sub-surface platform. The one-way travel distance to a platform exit should be not more than 20 m. Exits should not be more than 100 m apart.

14.4.2 Surface stations

There should be at least two exits from a surface station platform. The one-way travel distance to a platform exit should be not more than 20 m.

14.5 Escape routes

Sub-surface stations should have at least two protected routes passing through the station and leading to street level. These escape routes should remain independent up to and including the station exterior (final exit).

NOTE 1 Unlike other buildings, the use of escalators as part of the means of escape is an acceptable approach in railway premises. Escalators may be located within protected routes.

Where escalators form part of the means of escape strategy within public areas of railway stations, their components should be constructed of materials classified as A1 in accordance with [BS EN 13501-1:2018](#) wherever practicable.

NOTE 2 It might not be practicable for some components to be classified A1 (e.g. cables, handrails, motors and control equipment).

Escalators should conform to BS EN 115-1.

The means of escape should not rely on the use of trains for the evacuation of passengers.

14.6 Escape capacity

To establish the escape capacity for platforms and stations, two types of emergency scenario should be used in their worst-case situations:

- a) train on fire in the station; and
- b) fire within the station structure.

Surface stations should be designed such that there is sufficient escape capacity for platforms to be cleared within 8 min and the occupants cleared from the station to a place of ultimate safety within 12 min.

Sub-surface and enclosed stations should be designed such that there is sufficient escape capacity for platforms to be cleared within 4 min, and should enable travel from the most remote point on the platform to a place of ultimate safety or to a protected route within 6 min. The flow capacity of a protected route should be maintained throughout the whole of the route to a place of ultimate safety. Where protected routes merge, the capacity of the merged protected route should be not less than the combined capacity of the merging routes.

The vertical and horizontal capacity for each element should be determined in accordance with [Table 1](#).

Table 1 — *Vertical and horizontal escape capacity*

Element	Capacity
Horizontal passageways, stopped moving walks, and ramps <1:20	80 people per minute per metre width
Stairs (measured between the innermost part of the handrails) ^{A)} , and ramps ≥1:20	56 people per minute per metre width
Automatic ticket gates in the open position (standard width gates)	50 people per gate per minute
Automatic ticket gates in the open position (wide aisle gates of minimum width 900 mm)	80 people per gate per minute
^{A)} This might be different to the width calculated using BS 9999:2017 , where handrails and strings which do not intrude more than 100 mm into the stair width can be ignored.	

No allowance should be made for edge effects for stairs and passageways.

Where the total vertical rise served by stairs exceeds 15 m, the escape capacity and travel speed for stairs should be adjusted downward by 30% over the entire rise to account for fatigue.

Ticketing gates should be treated in the same way as horizontal passageways for calculation of escape capacity.

It should be assumed that escalators will continue to operate in the direction they were operating in prior to the start of evacuation. It should be assumed that one escalator, in the least capacious section of the busiest escalator route within the station, will be out of operation, inaccessible to the public, and unable to be brought into operation at the start of evacuation.

Where escalators are to be used as part of the means of escape, the escape capacity should be determined in accordance with [Table 2](#), assuming a nominal escalator width of 1 m.

Table 2 — *Escalator escape capacity*

Escalator travel speed	Capacity
<30 m/min	56 people per minute per metre width
≥30 and ≤45 m/min	75 people per minute per metre width
>45 m/min	120 people per minute per metre width

The travel speeds shown in [Table 3](#) should be used in calculating the time to an escape point and/or to a protected route.

Table 3 — *Pedestrian travel speeds*

Element	Pedestrian travel speed
Horizontal circulation	38 m/min
Vertical circulation (height of stairs)	12 m/min

14.7 Methodology to be used in calculating escape capacity

NOTE The recommendations in this subclause are designed to minimize the likelihood of passengers having to pass a train on fire or move through a train on fire to escape from a station.

14.7.1 Fire on a train in the station

For this scenario it should be assumed that a train is on fire in the station at the busiest platform or at a platform served by the busiest common route from adjoining platforms.

NOTE 1 The busiest platform or common route serving adjoining platforms is the one with the greatest total of passengers on the train (or trains) plus passengers on the platform (or platforms). It is important when establishing the number of passengers to include passengers that might be alighting on an adjacent platform.

Evacuation capacities should be calculated for the escape routes from each platform in turn, until the point in the station at which the escape routes from different platforms merge. From that point, the capacity of the escape route should be based on an evacuation from the busiest platform or busiest common route from adjoining platforms, combined with normal passenger flows from other platforms and other common routes from adjoining platforms. For the purposes of these calculations, all platform exits should be counted as being available, irrespective of their potential proximity to a fire.

The number of passengers assumed to be on the platform at start of evacuation should be the number of passengers on the train on fire, plus the number of passengers awaiting that train. The figure for waiting train passengers should be based on peak usage, incorporating either a 5 min delay to the scheduled train service or after a gap in the service of one cancelled train, whichever produces the largest number of station occupants.

NOTE 2 The peak usage for evacuation is normally based on the maximum occupancy, taking into account the forecast rail operation frequency.

In most cases, it should be assumed that the number of passengers on the train will be equal to the maximum normal design payload, as calculated in accordance with BS EN 15663, for the train stock that will use the line. If the train service has only allocated seating and does not allow for standing passengers, the maximum seating load should be used. It should be assumed that any train using the line that can be safely accommodated by the station platforms might have to stop at that station and evacuate in the event of a fire emergency.

NOTE 3 The trains with the maximum occupancy might not necessarily be those scheduled to stop at the station in normal service.

For locations where reliable alternative service usage forecast data is available to use as the basis of calculations, a value less than the maximum normal design payload may be used. In such cases, a suitable factor of safety/uplift should be added to the forecast service usage data. The use of this approach, as well as the safety margin to be used, should be agreed by stakeholders at the SCW (see 4.5).

The normal train service (with no cancellations) should be assumed on all the other platforms that are served by the evacuation route under consideration. Thus, the evacuation loads to be evacuated from these other platforms should be assumed to be the number of passengers waiting for a train plus the number of passengers alighting from the train.

At terminating stations, in cases where signalling cannot be changed in time to prevent further trains from entering during an emergency evacuation, it should be assumed that multiple trains are able to arrive at the station.

NOTE 4 The number of arriving trains is dependent on the design of the system, and needs to be coordinated with the railway systems team and or train timetabling.

NOTE 5 Worked examples for calculating platform and station clearance times are given in Annex A.

14.7.2 Fire within the station structure

An analysis should be undertaken to determine the most challenging evacuation scenario, and this should be accounted for in determining the escape capacity.

It should be assumed that there is a fire affecting the most capacious of the routes that would normally be used by occupants evacuating the station, and that the entire evacuation load from all platforms will be via other routes.

The number of occupants to be evacuated from the station should be calculated as the sum of the peak time boarding and alighting loads on each platform apart from the busiest platform. All such occupants should be assumed to be on platforms at the start of evacuation.

The number of occupants assumed to be on the busiest platform should be adjusted either for a 5 min delay to the scheduled train service or after a gap in the service of one cancelled train, whichever produces the largest number of station occupants. This should be based on the average number of passengers waiting for a train plus the number of passengers alighting from the train at the height of the peak.

NOTE Worked examples for calculating platform and station clearance times are given in [Annex A](#).

The escape capacity for public areas other than platforms should be designed in accordance with [BS 9999:2017](#).

14.8 Platform sizes

Platforms should have sufficient space to accommodate the entire occupancy calculated in accordance with [14.7.1](#), with an allowance of not less than 0.5 m² per person.

NOTE This corresponds approximately to a Fruin “Level of service” classification E (Fruin, 1971 [2]); there might be a requirement to design platforms to be larger than this for non-fire-safety-related reasons.

15 Means of escape from non-public areas of stations

15.1 Risk profile

For the non-public areas, usually referred to as Back of House (BoH), the risk profile should be established in accordance with [BS 9999:2017](#), Table 4.

NOTE It is important that the correct profile is established, taking into account the occupancy characteristics and fire growth rates. For non-rest areas it can generally be assumed that occupants are awake, but it will need to be established how familiar they are likely to be with the building with permanent staff, visitors and contractors all taken into account.

Where sprinkler systems (or watermist systems, where relevant fire test protocols exist) are installed, the risk profile in [BS 9999:2017](#), Table 4 may be reduced by one level subject to the restrictions in [BS 9999:2017](#), 6.5.

15.2 Occupancy

The number of BoH occupants should be established to ascertain the maximum number that might require evacuating, taking into account the floor space factors shown in [Table 4](#).

Table 4 — BoH floor space factors

Use type	Floor space factor m ² per person	Station associated area
Retail	2	Shop areas accessible by staff only
Office	6	Normally occupied BoH areas
Plant and equipment areas	See Note	BoH areas that are not normally occupied
<i>NOTE</i> Stations generally have low occupancy in BoH plant and equipment areas. It is advisable to consult stakeholders, including operators and infrastructure managers, on the relevant floor space factor to use.		

15.3 Travel distances

The travel distance (one-way and two-way) when minimum fire protection measures are provided should not exceed the value given in [BS 9999:2017](#), Table 11 for the appropriate risk profile.

NOTE 1 The minimum fire protection requirements are those that include both active and passive measures of fire protection, e.g. detection, alarm, restricting the development of a fire and securing the safe escape of the occupants, as described in [BS 9999:2017](#), Clause 15 to Clause 17.

If additional fire protection measures are provided, the travel distance may be increased subject to the limitations set out in [BS 9999:2017](#), Clause 18.

NOTE 2 For example, for risk profile B2, if the additional measures in [BS 9999:2017](#), Clause 18 are provided, the travel distance for one-way travel may be extended from a maximum of 20 m up to 24 m.

15.4 Escape provisions

The exit widths of doors should be not less than the values given in [BS 9999:2017](#), 16.6.1 and Table 12, for the appropriate risk profile.

The width of corridors and escape routes should be not less than the values given in [BS 9999:2017](#), 16.6.2.

The width of escape stairs for simultaneous evacuation should be not less than the values given in [BS 9999:2017](#), 17.4.1 and Table 13, for the appropriate risk profile.

Generally, railway stations incorporate an investigation time that is programmed into the fire alarm control panel as part of a two-stage alarm. In areas where it might take occupants longer to stop work and evacuate (e.g. machinery and plant areas) during any delayed evacuation procedure, the signal to evacuate should be given in these areas immediately upon detection of fire. This should be incorporated into station operational procedures.

NOTE 1 If a BoH voice alarm system is present, a standard coded message that staff will recognize can be issued in accordance with the requirements for staged fire alarms in [BS 5839-1:2017](#).

Suitable routes for BoH personnel to escape to a place of ultimate safety should be present in station BoH areas. They should meet the criteria for escape routes in [BS 9999:2017](#), or be such that a person confronted by fire can make a safe escape through an alternative exit.

NOTE 2 Evacuation from BoH areas where fire separation to the public areas is present in accordance with [44.2.3](#) can be considered as part of a progressive evacuation strategy in accordance with [BS 9999:2017](#), 12.3.

NOTE 3 The BoH personnel can be evacuated into an adjoining fire compartment, which can be into the public areas of the station.

The public area should be provided with suitable means for onward evacuation to a place of ultimate safety.

NOTE 4 Recommendations for evacuation of public areas are given in [Clause 14](#).

The BoH areas, unless specifically designed to accommodate evacuating passengers, should not be used as a route for public evacuation. The escape route should be clearly and unambiguously indicated by signage, and any doors providing access to locations that are not part of the escape route should be kept locked closed at all times when the station is occupied by the public.

The BoH accommodation areas where station personnel are required to manage evacuation and liaise with the fire and rescue services, e.g. in a station control room, should be provided with a minimum of a 2 h fire-resisting construction and a 2 h protected route to outside (if not directly accessible from outside). Any equipment necessary to maintain their safety in case of fire (such as ventilation) should be configured such that a fire does not compromise its function.

NOTE 5 Recommendations for access and facilities for firefighting are given in [Section 5](#).

16 Means of escape for persons with restricted mobility (PRM)

COMMENTARY ON CLAUSE 16

Railway infrastructure is increasingly being built or altered to make it accessible to those who either cannot use stairs, or might not be able to ascend or descend staircases swiftly and easily. Ramps and lifts are used to make the journey from street to platform (and interchanges between platforms) step-free.

It is important that inclusive design extends to the provision of means of escape in case of fire, such that disabled people or other PRM can evacuate the premises in case of a fire emergency whilst not being exposed to an unacceptable level of fire risk.

It might be necessary to include any of the following features in the design of escape routes to assist PRM:

- *use of horizontal evacuation to a different fire compartment;*
- *use of lifts;*
- *making all escape routes accessible, by adding ramps if necessary; and*
- *fitting extra handrails and step edge markings.*

This clause gives recommendations for the design aspects of means of escape for disabled people.

The management of means of escape for disabled people is covered in [BS 9999:2017](#), Clause 45.

16.1 Provision of accessible means of escape

The basis of the means of escape strategy for PRM should be that they are not exposed to a significant additional risk from fire, compared with those who can readily use stairs or escalators to reach a place of safety.

NOTE Whether the individual risk that a PRM faces from fire is low or not, it is important that it is approximately equivalent to other occupants in the same location, so that there is no discrimination regarding levels of fire safety.

If procedures involve a delay in the evacuation of PRM whilst they await assistance to commence the next stage of their movement to a place of safety, any pauses should be kept as brief as possible. The evacuation sequence for PRM should enable them to reach a place of ultimate safety with no significant delay, compared to the rest of the occupants of the premises. The evacuation of PRM should not be delayed for an extended period compared with others; their evacuation should be a continuation of the process used for the other occupants. For unstaffed stations, the means of escape route should allow PRM to proceed to a place of safety unaided.

Evacuation by train should not be relied upon to provide accessible means of escape from any location.

The number and locations of accessible means of escape should follow the general recommendations for means of escape in [BS 9999:2017](#), Clause 16 and Clause 17.

16.2 Provision of refuges

COMMENTARY ON 16.2

Refuges are locations where an evacuation sequence pauses for a limited amount of time; they cannot be regarded as locations where extended waiting can be safely accommodated. In all cases, the evacuation sequence for PRM needs to be completed as soon as is practicable and without any undue delays.

It is not acceptable for occupants to be expected to remain in refuges in anticipation that they might be evacuated by the emergency services or staff based at other locations. The use of refuges is therefore not acceptable in unstaffed stations.