Draft for Public Comment

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Title: Draft BS 9992 Fire safety in the design, management and use of rail infrastructure - Code of practice

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard
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Introduction
Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international and European standards, comments will be reviewed by the relevant UK national committee before submitting the consensus UK vote and comments. If the draft standard is approved, it is usual for the resulting published standard to be adopted as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote
Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments
Annotated drafts are not acceptable and will be rejected.

All comments should be submitted online at **http://standardsdevelopment.bsigroup.com**. You will need to register in order to comment.

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

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on XX Month 201X. 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 or extinguishing systems, smoke control, pressurisation and extract systems, fire resisting structures and separating elements, materials with fire performance requirements);
- regulators;
- maintainers.

BS 9992 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 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, fire-fighter safety, 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 a high level of protection for buildings, business and property in case of a fire of significant severity.

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.

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.

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, fire-fighting tactics and the likely spread of fire.

Whilst the use of 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 fire-fighting access and escape distances far in excess of those generally recommended for buildings. The practicality of driving shafts or tunnels which would bring those distances into compliance with the guidance for general buildings is generally prohibitive in terms of cost.
- 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 follows the established approach applied to those structures, rather than the standards applied to buildings.
- Railway stations can be regarded, in the main, 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. 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 (though some heritage stations do incorporate substantial timber structures). Partly for this reason, travel distances greater than those accepted in other types of buildings can often be safely accommodated.
- The operational response to a fire on a train is often to bring it into the next available station, if possible to do so, as it is normally from these locations where means of escape can happen most swiftly, and fire-fighting 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 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.
- 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 fire-fighting 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, and it is therefore particularly important that in such cases the key stakeholders are consulted prior to the design being finalised and the works commencing, 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 be preserved[1)];
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

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1) 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.

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.

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

1) the potential users of the building (both staff, maintainers and members of the public);
2) the hazard posed by other occupancies or premises (and vice versa), including boundary conditions;
3) provision for giving warning in the event of fire, including any automatic fire detection;
4) the provision of automatic fire suppression or extinguishing systems;
5) smoke clearance and smoke control arrangements;
6) the overall management and control of the premises, including staffing numbers and whether those vary throughout the period the premises are occupied;
7) structural fire protection and compartmentation;
8) the fire performance of the materials from which the premises will be constructed, both internally and externally;
9) fire-fighting access to the building (including vehicles);
10) the facilities provided for firefighters;
11) fixed and portable fire-fighting equipment;
12) fire safety signage;
13) emergency lighting;
14) 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 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 so that they can practicably be complied with. Where these arrangements require the endorsement of the safety and functionality of the works by fire safety specialists, then it is advisable for those specialists to be appointed before any works involving assets that have a fire safety function commence on site, and for there 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 so that they can practicably deliver that assurance.

Where the works are being delivered by a number of suppliers (e.g. 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) 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. Attention is drawn to the legal requirement for cooperation and coordination of works to manage fire safety effectively.

1 Scope

This British Standard gives recommendations and guidance on the design, management and use of rail infrastructure 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 elevated);
- platforms;
- tunnels;
- bridges;
- elevated rail;
- depots;
- training facilities;
- sidings;
- signalling/control facilities;
- ancillary buildings.

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

This British Standard is applicable to both new build and alterations to existing rail infrastructure.

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 document[2)]. 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, *Structural timber – Sizes, permitted deviations*

BS 795, *Personal fall protection equipment – Anchor devices*

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*

[2)] Documents that are referred to solely in an informative manner are listed in the Bibliography.

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

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 5499-4, *Safety signs – Code of practice for escape route signing*

BS 5499-10, *Guidance for the selection and use of safety signs and fire safety notices*

BS 6266, *Fire protection for electronic equipment installations – Code of practice*

BS 6853, *Code of practice for fire precautions in the design and construction of passenger carrying trains*

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

BS 7883, *Code of practice for the design, selection, installation, use and maintenance of anchor devices conforming to BS EN 795*

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

BS 8491:2008, *Method for assessment of fire integrity of large diameter power cables for use as components for smoke and heat control systems and certain other active fire safety systems*

BS 8519, *Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice*

BS 8591, *Remote centres receiving signals from alarm systems – Code of practice*

BS 9990:2015, *Non-automatic fire-fighting systems in buildings – Code of practice*

BS 9999:2017, *Fire safety in the design, management and use of buildings – Code of practice*

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*

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*

[3)] This British Standard gives specific references to BS EN 12101-6:2005 and BS EN 12101-8.

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 45545 (all parts), *Railway applications – Fire protection on railway vehicles*[4)]

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 50200:2015, *Method of test for resistance to fire of unprotected small cables for use in emergency circuits*

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

BS EN 60332-3-24:2009, *Tests on electric and optical fibre cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wires or cables – Category C*

BS EN 60332-3-25:2009, *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 61508-1:2010, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements*

BS EN 61034-2:2005+A1, *Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements*

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

BS EN ISO 7243:2017, *Ergonomics of the thermal environment – Assessment of heat stress using the WBGT (wet bulb globe temperature) index*

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

BS ISO 3864-4, *Graphical symbols – Safety colours and safety signs – Part 4: Colorimetric and photometric properties of safety sign materials*

ISO 834, *Fire resistance tests – Elements of building construction.*

ISO 2922, *Acoustics – Measurement of airborne sound emitted by vessels on inland waterways and harbours*

Other publications

[N1] RSSB. *Lineside operational safety signs*. GI/RT7033. London: RSSB, 2009.

[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.

4) This British Standard gives specific references to BS EN 45545-2:2013+A1:2015.

[N4] RSSB. *Railway industry standard for lighting at railway stations*. RIS-7702. London: RSSB, 2013.

[N5] 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.

[N6] 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.

3 Terms and definitions

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

3.1 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.

3.2 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 fire-fighting 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**]

3.3 fire safety manager
nominated person carrying out the job of management of fire safety

[SOURCE: BS 9999:2017, **3.49**]

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

3.5 front of train
any point forward of the middle point of a train

3.6 grade level
level at which the ground surface meets the foundation of a building

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

3.7 permanent way
guidance and support system for rail vehicles

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

3.8 persons with reduced mobility (PRM)
persons who have difficulty accessing trains or the infrastructure, including but not limited to wheelchair users, people with mobility impairments, people who are blind or partially sighted, and people who are Deaf or hard of hearing

NOTE PRM is a term that has been adopted in the UK railway environment and can refer to persons that can include anyone whose mobility is restricted. This category includes persons who can use stairs but might not be able to reach a place of safety in the normal movement times.

3.9 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**]

3.10 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]

3.11 platform
area in a station that provides direct, level access to trains (not including corridors)

3.12 platform exit
position where persons can leave a platform

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

3.14 stations

3.14.1 enclosed station
station where at least one platform accessible to the public and its associated permanent way is enclosed continuously for over 50 m

3.14.2 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

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

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

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.

Passengers should not have to pass a train on fire or move through a train on fire to escape from a station.

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 1 This could include enhanced compartmentation, automatic suppression and phased emergency evacuation.

NOTE 2 Where there are requirements for property protection/business continuity, it is likely that they will need to be informed by the duty holder, the client (if different) and/or any insurers who have an interest in the relevant infrastructure.

4.3 Mixed-use buildings

Where transport facilities incorporate mixed use, such as retail shopping units/shopping malls, or office space and training facilities within control centres, these facilities should be in accordance with the relevant annexes in BS 9999:2017. Control centres should be in accordance with Section **8** of the present standard. In all cases the non-railway parts of the building should be designed and constructed such that they are able to operate independently from the railway 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 Large signalling and control centres require a high level of security provision around their perimeters.

The designers should consult with the any security specialist employed by the duty holder and the relevant police authorities (this should normally be facilitated by the duty holder, who is likely to have a working relationship with the police and security services).

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.

The effectiveness of the CSW 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 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;

*h) a structured agenda that covers the items listed in **4.5.3**.*

The SCW, if properly constituted and conducted, forms a virtual contract between the project team and the regulator(s) regarding the most important fire safety objectives and requirements for the works. 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 10 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, and some attendees might refuse to consider them if they are.*

The 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.

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 summarise 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 attend in order for the SCW to take place:

a) representatives of 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);

h) the relevant fire authority (or authorities, if the works span multiple jurisdictions).

NOTE 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 the proposed scope of works; the outline programme; how the premises is/will be operated; what the existing and planned provisions for fire protection are and why the designers assessed these acceptable.

The SCW should be chaired by a competent fire safety engineer, who should not be either the designer of the works or 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 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. Simultaneous escalation in all the stakeholders' organizations might be necessary, in order to explore resolution, but ultimately it is those who have a formal safety regulatory function that determine what is acceptable.

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 PRM) and the potential need for any evacuation simulations;

   2) access and facilities for fire-fighters;

   3) means of giving warning in case of fire;

   4) fixed and portable fire-fighting equipment;

   5) automatic fire-fighting 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) smoke simulations;

   13) fire safety emergency management arrangements for the premises, including staffing levels;

   14) interfaces with attached, adjacent, or associated premises where they may be affected by a fire in the premises being discussed

   15) the site boundary conditions, where these could affect fire safety.

   16) security or revenue protection arrangements (where these could affect 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 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 and implementation of the management of fire risk should be in accordance with BS 9999:2017, Section **4** and Section **9**.

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 [1] 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 [2], the Fire Safety (Scotland) Regulations 2006 [3], and the Fire Safety Regulations (Northern Ireland) 2010 [4].

The following areas should be assessed in all railway premises:

a) means of escape (including for PRM);

b) fire detection and fire alarm systems;

c) fire suppression;

d) hazardous materials;

e) portable fire-fighting equipment;

f) fire signage;

g) emergency lighting;

h) passive fire protection;

i) access and facilities for fire and rescue services;

j) smoke control systems;

k) training, instruction and information;

l) evacuation plan;

m) housekeeping;

n) planned review of the risk assessment;

o) actions required to be taken (with timescales).

The person undertaking the risk assessment should be suitably qualified and with applicable experience.

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 prepared for fire incidents.

The emergency plan should contain a list of relevant contacts that could be necessary during an emergency incident, including but not limited to emergency services, control centre, station manager and train operating company manager.

For railway infrastructure, 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 1 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.

Following a fire incident, re-entry into the affected part of the premises by members of the public should be prevented until the required permissions have been given by the attending senior fire service officer.

NOTE 2 To discourage passengers from entering a station during a fire incident, an "Emergency Do Not Enter" sign can be affixed to station entrances.

The risks to the premises should be evaluated with regard to:

a) fire and smoke;

b) security alerts/bomb threats;

c) flooding;

d) adverse weather;

e) gas leaks;

f) chemical leakage or spills.

The planned responses to all these incidents should be covered in the emergency plan.

8 Failure or non-availability of equipment

The integrity and reliability of fire detection and fire alarm systems should not be compromised by integration with or connection to any other system. Fire detection and fire alarm systems should continue to be fully functional in the event of the failure of any other system.

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. Where the failure or non-availability could affect fire and rescue operations, it should also be communicated to the relevant fire authority.

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;

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

The length of time for which it is acceptable for the premises to remain open whilst any specific fire protection systems are temporarily not fully functional should be clearly stated in the plan. The duration of any such failure should be minimized and actively managed.

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 many respects, railway facilities do not differ greatly from other types of building with similar occupancies, so most of the recommendations in BS 9999:2017, Section **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 cases. 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 Initial design input

Prior to the design process commencing, the designer should obtain an operational concept for all facilities that are included within the works. This 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) where the facility is to be owned, managed, operated or maintained by different organizations, how the division of responsibilities will be configured and how the interfaces will be managed;

c) where it could influence the fire safety of the premises, the type and configuration of rolling stock likely to be present (including non-passenger rolling stock, if relevant);

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 depots/stabling 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;

h) an outline (draft) emergency management plan that includes the fire safety management arrangements for both staff and passengers (including non-ambulant passengers).

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.

When construction is under way, the operator(s) should be afforded access to the site of the works so that they can inspect and understand the various fire safety systems, some of which might not be visible at the time when installation is complete. 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 and installation of those systems, and should also be afforded access to the works, for familiarization purposes.

10.2 Staffing levels

*COMMENTARY ON **10.2***

Those railway facilities 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.

Once the fire safety design reaches a sufficient level of completion, the railway operator (or their representatives) should conduct task analyses to determine the minimum 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 both on 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.

Where management assumptions concern the fire-fighting and rescue activities of the fire and rescue service, they should be consulted to ensure that those assumptions are valid.

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 those 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

Where the design relies upon pauses in the evacuation sequence whilst staff prepare to assist non-ambulant occupants to escape, or where any occupants are expected to wait for assistance in defined locations within the premises, then 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, and that their onward route off the premises is similarly protected from fire risk. The managers of the premises should be consulted to ensure that those locations are acceptably safe with regard to other types of hazard and risk (e.g. slips, trips, falls, touching exposed current-carrying conductors, exposure to passing 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 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.

NOTE It is not acceptable to state simply that management procedures should or will be developed to cater for evacuation. The detail has to be included in the design.

Means of escape from tunnels and viaducts should be designed in accordance with Section **6** of the present standard.

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

NOTE These areas include, but 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, usually referred to as Front of House (FoH), 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, might not be familiar with alternative evacuation routes/provisions.

The 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, Table 4 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.

NOTE 3 In some cases classifications higher than EI 60 might be required for compliance with other parts of this British Standard.

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 (e.g. those passengers within the public areas of station waiting to board trains); and

b) passengers alighting from trains.

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 an agreed passenger foot fall, or origination 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. 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, and the potential for the retail premises to form a destination rather than the railway services, the floor space factor given in BS 9999:2017, Table 9 should be used to account for the additional station occupancy.

14.3 Means of egress

*NOTE For bridges and viaducts, the access walkway provided for the fire and rescue service (see Section **5**) can be used for egress.*

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;

c) means to provide fire separation between different occupancies/premises in accordance with BS 9999:2017, Section **7**.

If progressive horizontal evacuation is deemed to be more 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 egress 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.

If platform edge doors are installed, they should have means 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 mis-alignment 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 premises, 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

NOTE Unlike other buildings, the use of escalators as part of the means of escape is an acceptable approach in railway premises.

Where escalators form part of the means of escape strategy within public areas of railway stations, they should be constructed of materials classified as A1 in accordance with BS EN 13501-1:2018 wherever practicable, and equipped with manual stopping devices accessible from both upper and lower landings.

Sub-surface stations should have at least two fire 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).

14.6 Egress capacity

To establish the egress 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;

b) fire within the station structure.

Surface stations should be designed such that there is sufficient egress capacity for platforms to be cleared in 8 min and the station cleared within 12 min.

Sub-surface and enclosed stations should be designed to permit evacuation from the most remote point on the platform to a place of ultimate safety or to a protected route in 6 min or less. Platform clearance should be within 4 min.

NOTE A protected route is provided with means to ensure that the persons escaping are protected from the heat and effluents of the fire, and leads to a safe location outside the station.

It might be possible for passengers to be evacuated by train, but the planned station egress capacity should not rely on this.

The vertical and horizontal capacity for each element should be determined in accordance with Table 1.

Table 1 – Vertical and horizontal egress capacity

Element	Capacity
Horizontal passageways and stopped moving elements	80 people per minute per metre width
Stairs (measured between the innermost part of the handrails) and static escalators.	56 people per minute per metre width

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

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

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

Escalators should continue to operate in the direction they were operating in prior to start of evacuation. One escalator should be assumed to be out of operation and unable to be bought into operation at the commencement of evacuation at each station level.

Where escalators are to be used as part of the means of egress, the egress capacity should be determined in accordance with Table 2, assuming a nominal escalator width of 1 000 mm.

Table 2 – Escalator egress 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 egress point and/or to a protected route.

Table 3 – Pedestrian travel speeds

Element	Pedestrian travel speed
Horizontal circulation	38 m/min
Vertical circulation	12 m/min

14.7 Assumptions to be used in calculating evacuation capacity

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 upon 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.

The number of passengers assumed to be on the platform at start of evacuation 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.

It should be assumed that the number of passengers on the train will not exceed 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. The trains with the maximum occupancy might not necessarily be those scheduled to stop at the station in normal service, but should be assumed that any train using that line might have to halt at the station and evacuate in a fire emergency.

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, it should be assumed that several trains are able to arrive at the station, as signalling cannot be changed in time to stop them from entering.

NOTE 3 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 4 Worked examples for calculating egress times are given in Annex A.

14.7.2 Fire within the station structure

For this scenario it should be assumed that there is a fire in the most capacious of the normal customer routes through the station and that the entire evacuation load from all platforms will be via other routes.

All passengers within the station should be assumed to be on platforms at the start of evacuation (as this is the worst case).

Station occupancy 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.

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 egress times are given in Annex A.

14.8 Platform sizes

Platforms should have sufficient space to accommodate the entire evacuation occupancy (calculated in accordance with **14.2**) with an allowance of not less than 0.5 m^2 per person.

NOTE This corresponds approximately to a Fruin "Level of service" classification E (Fruin, 1971 [5]); 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.

NOTE 1 Table 4 uses extracted information from BS 9999:2017, Table 9, applied to BoH areas in railway stations.

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	General back of house areas

NOTE 2 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 Egress provisions

The exit widths of doors should be not less than the values given in BS 9999:2017, Table 12, for the appropriate risk profile.

The width of escape stairs for simultaneous evacuation should be not less than the values given in BS 9999:2017, Table 13, 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**.

In open stations, defined areas on platforms might be suitable as refuges where PRM can wait in open air. Where this is proposed, it should be demonstrated that the refuge will remain safe (i.e. not rendered untenable by fire or smoke) during any foreseeable fire incident.

Generally, railway stations incorporate an investigation time programmed into the fire panel as part of a two-stage alarm. For persons located in areas that do not need to remain occupied during any delayed evacuation procedure (e.g. machinery and roof plant areas), the signal to evacuate should be given immediately if a fire is detected. Delays for investigation time should not be incorporated, and evacuation should commence on the first stage of a two-stage alarm notification. This procedure should be incorporated into station operational procedures.

NOTE 2 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 egress 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 3 Evacuation from BoH areas where fire separation to the public areas is present in accordance with **45.2.3** can be considered as part of a progressive horizontal evacuation strategy in accordance with BS 9999:2017, **12.3**.*

NOTE 4 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 5 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 fire 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 6 Recommendations for access and facilities for fire-fighting 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 who 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;*
- *make 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 occupants 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 PRMs 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.

Evacuation by train might be possible, depending upon the nature of the fire emergency, but it 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 **16.3***

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.

Refuges should be provided in any location where the evacuation sequence for PRM pauses whilst preparations are made for subsequent stages in their evacuation.

For locations within buildings, refuges should meet the recommendations in BS 9999:2017, Annex G.

Where refuges are located in the open air on platforms (i.e. they are open to the sky, or are weather-protected by open-sided canopies that cover only the platform and not the permanent way), the following recommendations should be met.

a) Refuges should be identifiable by designated and defined clear areas.

b) At least two refuges should serve each platform.

c) The two refuges should be separate from each other with each being as close as is reasonably practicable to a different platform exit.

Such refuges should be provided with all the other safety features recommended for refuges in BS 9999:2017, Annex G, except that they do not need to be surrounded by fire-resisting construction.

To calculate the recommended number of refuge spaces to be provided at any location where the evacuation sequence for PRM passengers from platforms might pause, it should be assumed that:

1) all wheelchair spaces on the train on fire are filled (using the rolling stock scheduled to call at the station with the maximum number of such spaces), and

2) the same number of wheelchair users are on the platform waiting to board, for all lines served by that platform.

Sufficient wheelchair-accessible space should be provided at each refuge to accommodate the calculated number of wheelchairs, using the refuge dimensions recommended in BS 9999:2017, Annex G.

NOTE The calculation takes this form:

Refuge spaces per platform (N) = (2 × PRM spaces on the train on fire) + (for island platforms only, maximum number of designated PRM spaces for the trains serving the other platform).

For example:

- *for a single-faced platform served by a train that has four designated wheelchair spaces, cater for 2 × 4 = 8 spaces in each refuge;*
- *for an island platform with the same type of rolling stock on both sides, assume that 2 × the train capacity is waiting to board (in the above example, 8 PRM boarders on the platform plus 4 PRM on the train on fire = 12 spaces in each refuge).*

Any intermediate refuges (e.g. on concourses) should be sized to hold the summation of the capacities for all the other refuges they serve (e.g. a mid-level concourse that serves two platforms each with four refuge spaces would need eight refuge spaces).

Refuges that do not serve evacuation routes from platforms and those serving non-public evacuation routes should be sized in accordance with BS 9999:2017.

Where refuges are to be located in fire-fighting lobbies within fire-fighting shafts, the size of those lobbies should be constrained to the maximum and minimum dimensions recommended in BS 9999:2017.

16.3 Use of lifts for the evacuation of PRM

*COMMENTARY ON **16.4***

Where evacuation is required for railway passengers, it is not advisable to rely upon members of staff manually carrying persons up or down stairs, or upon the manual transfer of wheelchair users from their own chair to an evacuation device.

Carrying people up or down stairs can be a very strenuous activity, and where people require transfer from their own wheelchair to another evacuation device this can involve several members of staff assisting. It can also be distressing for the wheelchair user. In railway premises it is usually difficult to predict the number of members of the public who might require such assistance in case of a fire emergency. Unless there is a high degree of confidence that a sufficient number of fit, trained staff will be readily available and able to undertake multiple evacuation sequences if necessary, ramps or evacuation lifts offer a more robust and reliable means of accessible egress.

All lifts designed in accordance with the relevant parts of BS EN 81 are automatically recalled to a designated landing upon activation of any fire detection system in the premises and cease to respond to landing or car controls. This applies whether they are evacuation, fire-fighting or standard lifts. Only fire-fighting and evacuation lifts can thereafter be used for evacuation under staff control. This precludes the possibility of using any type of lift for self-evacuation, in premises fitted with a fire detection and fire alarm system.

The accessible vertical means of escape should utilize level egress (e.g. ramps) or lifts.

Where lifts are used in the evacuation sequence, they should be fire-fighting or evacuation lifts that meet the relevant recommendations in BS 9999:2017, **20.4** or Annex G.

Other lifts should not be used as part of an evacuation sequence for PRM.

No part of the premises should be served only by a lift. It should be possible to access all locations via stairs or escalators.

16.4 Fire protection of lifts and refuges

16.4.1 Open areas

Lifts that are to be used for evacuation should be enclosed in a shaft or well that is constructed from materials classified A1 or A2 to BS EN 13501-1:2018. All parts of the shaft and/or well facing the platforms should be imperforate and without openings. Glass should not be used to enclose the lift unless it is part of a fire-resisting wall system classified at least EI 30 in accordance with BS EN 13501-2:2016.

NOTE Where lift wells are in open areas, it is not necessary to locate the lift and refuges within fire-resisting structure, if:

- *the lift is on a surface platform; and either*
- *the platform is not weather-protected; or*
- *any overhead weather protection covers only the platforms, not the track.*

Areas should be designated on platforms that can be used as refuges. These should meet the recommendations in BS 9999:2017, Annex G, with the exception that they need not be enclosed in fire-resisting construction. There should be at least two refuges per platform, spaced sufficiently far apart so that a train fire would not compromise the safety of more than one refuge.

Lifts and refuges should be provided with both normal and emergency lighting, and emergency voice communication systems in accordance with BS 5839-9.

16.4.2 Enclosed areas

Evacuation lifts that are enclosed within buildings should be associated with refuges at all levels where they provide a means of escape. The lifts and refuges should meet the recommendations in BS 9999:2017, Annex G.

Section 5: Access and facilities for fire-fighting

*COMMENTARY ON SECTION **5***

Within the railway environment there are significant challenges for the fire and rescue services, which include stations below and above ground, tunnels for sub-surface transport infrastructure, and large enclosed surface stations which can be combined with extensive retail facilities. The potential consequences of fire within this type of infrastructure and the challenges faced necessitate the provision of facilities additional to those normally provided for buildings. These facilities are intended to avoid delay in fire-fighting response and to provide a sufficiently secure operating base, thus allowing the fire and rescue services to implement safe systems of work.

Well-designed access and facilities provide means for fire-fighters to respond in a timely way, carrying their equipment along with adequate water supplies, and for activation of any fire-fighting equipment fixed in stations working effectively to support emergency intervention. Such facilities are expected to reflect the likely risk to life and infrastructure from fire. The safety of both fire-fighters and the occupants of railway buildings and associated infrastructure, as well as the preservation of assets and maintenance of business continuity, can be jeopardized by delays in reaching the area of the fire.

For railway infrastructure, where large numbers of the travelling public are present, providing suitable access and facilities for the fire and rescue services can be challenging. The infrastructure itself can pose additional problems due to the depth or height from fire and rescue service access level, and other features such as extended travel and hose distances.

*This section is not applicable to buildings under construction. Recommendations for measures to be taken during the construction phase regarding access and facilities for fire-fighting are given in Section **10**.*

17 General recommendations for fire-fighting facilities

In designing new railway infrastructure and the provisions for the safety of occupants from fire, account should be taken of the requirements for fire and rescue service access into and around buildings for fire-fighting purposes.

The capabilities of, and resources available to, individual fire and rescue services vary, and in all cases the fire and rescue services that might respond to incidents on infrastructure should be consulted at the earliest stages of design.

This consultation might involve multiple fire and rescue services where infrastructure such as bridges, viaducts or tunnels cross service boundaries.

NOTE 1 Fire-fighting facilities should be selected and designed to assist the fire and rescue service in protecting life and enabling the implementation of safe systems of work to protect fire-fighters.

NOTE 2 Additional objectives might also include the reduction of property/asset losses, salvaging property and goods, and minimizing environmental damage. The provision of appropriate fire-fighting facilities can assist in maintaining business continuity, by minimizing disruption to the infrastructure and the prolonged loss of assets that could result from fire incidents.

Early consultation with the relevant fire and rescue services should take place when designing fire-fighting facilities.

NOTE 3 The exact choice of facilities depends on the use, size or layout of the building/infrastructure, the nature of its contents, and the site upon which it is situated.

Access and facilities for fire-fighting should be in accordance with BS 9999:2017, Section **5**, except where recommended otherwise in Clause **18** to Clause **25** below.

The general recommendations for fire-fighting access and facilities given in BS 9999:2017, Clause **19**a) to h), should be met.

18 Fire-fighting shafts

18.1 Provision and siting of fire-fighting shafts

18.1.1 Provision of fire-fighting shafts

Fire-fighting shafts should be provided for railway infrastructure, including for buildings and tunnels, as shown in Table 5.

*NOTE General recommendations for tunnels are given in Section **6**.*

The number of fire-fighting shafts should be determined in accordance with **18.1.2**. Each fire-fighting shaft should contain all the appropriate facilities required.

The arrangement of any fire-fighting shafts and the associated facilities should be logical and simple, so that fire and rescue service personnel have no difficulty in locating the fire-fighting shafts serving the areas they need to reach. Where practicable, there should be a continuous vertical shaft which provides access to track level.

Where fire-fighting shafts serve separate parts of a station, they should be clearly identified as to the area(s) that they serve.

Table 5 – Provision of fire-fighting facilities

Type of building (qualifying storeys)	Facilities to be provided
Surface stations which, for example, have long open platforms [A)]	Fire mains This should be discussed with the relevant fire and rescue services at the earliest opportunity. For further details on fire main design, see Clause **20**.
Any building with a height of 11 m or more, but less than 18 m (For example, small, multi-storey surface station buildings which might also have elevated portions)	Escape stair [B)] Unvented protected lobby provided with a fire main [C)]
Buildings or parts of buildings where there are persons unfamiliar and/or travelling public present and the height of the topmost storey exceeds 7.5 m above fire and rescue service access level, with the floor area of any storey above the ground storey not less than 900 m^2 (not including unenclosed platforms)	Fire-fighting shaft, comprising: Fire-fighting stair Fire-fighting lobbies provided with a fire main
Any buildings or parts of buildings [D)] where the height of the topmost storey (excluding any storey consisting entirely of plant rooms) exceeds 18 m	Fire-fighting shaft, comprising: Fire-fighting stair Fire-fighting lobbies provided with a fire main Firefighters lift installation
Any buildings where the depth of the lowermost storey exceeds 10 m [E)]	Fire-fighting shaft, comprising: Fire-fighting stair Fire-fighting lobbies provided with a fire main Firefighters lift installation
Any buildings where there are two or more basement levels, each with a floor area [E)] exceeding 900 m^2	Fire-fighting shaft, comprising: Fire-fighting stair Fire-fighting lobbies provided with a fire main

A) Some new surface stations have long platforms and can only be accessed from the station buildings and main entrance. In these cases, foot bridges, underpasses or other mitigation for dead-end conditions might not provide suitable access and can result in excessive hose runs. In particular, fire and rescue services outside major metropolitan areas can experience significant delays in responding to incidents involving surface stations with long platforms if no fire mains are provided.

B) This does not imply that these stairs need to be designed as fire-fighting shafts.

C) See BS 9999:2017, **20.1.3**, Note 3.

D) The reference to parts of buildings covers situations such as buildings rising above a podium. It also includes elevated railway stations with a platform level above 18 m from fire service access level, irrespective of whether the platforms are enclosed.

E) All sub-surface railway stations and intervention shafts, irrespective of depth to platform or track level, should be provided with fire-fighting facilities to all platforms/track levels.

18.1.2 Number of fire-fighting shafts

COMMENTARY ON ***18.1.2***

The number of fire-fighting shafts required in a railway premises to facilitate effective fire-fighting access is not necessarily defined by floor area, such as the criterion given in BS 9999:2017 for at least two fire-fighting shafts to be provided in buildings with a storey of 900 m² or more in area. For example, enclosed stations with long platforms might or might not have a total floor area exceeding 900 m² situated on a single storey but in such cases the length of platforms is more relevant to fire-fighting than their combined area. However, for parts of stations that are independent of platforms and which might have large floor areas, such as back of house and ancillary service areas, the guidance in BS 9999:2017 is more appropriate.

Fire-fighting standard operating procedures vary between different fire and rescue services, and the number, location and siting of fire-fighting shafts should reflect the operational procedures that are likely to be implemented. This aspect of the design should be discussed with the fire and rescue services as the earliest opportunity.

The number and positioning of shafts serving tunnels should be in accordance with Section **6**.

A sufficient number of fire-fighting shafts should be provided to meet the maximum hose distances set out in in BS 9999:2017, **20.1.3**.

NOTE 1 Typically, this would be at least two shafts per platform. However, hose distances may be achieved by a combination of the siting of fire-fighting shafts and additional, intermediate fire main outlets on concourses or platforms. See Clause ***20*** *for further guidance on the siting of fire main outlets.*

NOTE 2 Enclosed stations with long platforms normally require the provision of multiple fire-fighting shafts in order to provide fire-fighters with a choice of means to approach a fire.

18.1.3 Siting of fire-fighting shafts

Fire-fighting shafts should be sited in accordance with BS 9999:2017, **20.1.3**, except that the firefighters lift need not serve the lowest level of the station if that level consists exclusively of the platform inverts or sumps. The fire-fighting shaft should serve every storey where there is an entrance to accommodation and/or building services.

18.2 Layout of fire-fighting shafts

18.2.1 General

The recommendations given in BS 9999:2017, **20.2.1** should be met, with the following exceptions.

a) For stations with surface and sub-surface platforms, firefighters lifts do not need to serve above-ground infrastructure if the height is less than 18 m.

b) Because it is the line of retreat if the firefighters lift fails, the fire-fighting stair should serve every storey served by the firefighters lift. The lift and stair are also used together during fire-fighting operations.

c) For sub-surface railway infrastructure, fire-fighting shafts should be provided with pressurization in accordance with the requirements of BS EN 12101-6:2005, Class B systems.

d) The design of the pressurization systems serving fire-fighting shafts should be coordinated with the design of any other smoke ventilation systems, e.g. tunnel ventilation systems that serve adjacent areas, in order to ensure that the combined pressure differentials do not result in excessive door opening forces (see Section **6** and BS 9999:2017, **27.1.3**).

18.2.2 Access level

The layout of the fire-fighting shaft at fire and rescue service access level should be in accordance with BS 9999:2017, **20.2.2**, and should be such that fire-fighters entering the fire-fighting shaft and persons escaping using the fire-fighting stair do not obstruct each other.

*NOTE 1 References to "down" in BS 9999:2017, **20.2.2** apply equally to "up", as would be applicable to sub-surface infrastructure.*

Where a station operation/control room is not located such that it can be used as a fire control centre, a suitable location should be provided at fire and rescue service access level which can be used for the same purpose.

*NOTE 2 Recommendations for fire control centres on railway infrastructure are given in **21.4**.*

If fire-fighting facilities (such as repeater fire alarm and/or ventilation system control and indicating panels) are provided within the egress route at ground floor level, these facilities should be provided within a recess to ensure that fire-fighters using them do not impact upon the escape route for members of the public, and vice versa.

The fire alarm sounders should not inhibit intelligible radio communications.

18.2.3 All other levels

The layout of fire-fighting shafts at all other levels should be in accordance with BS 9999:2017, **20.2.3**.

18.2.4 Fire-fighting stairs

Fire-fighting stairs should be in accordance with BS 9999:2017, **20.2.4**. If these stairs are also intended to be used as the means of escape, their clear width should be increased by 500 mm over the minimum needed to provide the necessary escape capacity.

NOTE This is to ensure that there is sufficient room for fire-fighters to use the stairs for access whilst the stairs are also being used as a means of escape.

18.2.5 Fire-fighting lobbies

Fire-fighting lobbies should be in accordance with BS 9999:2017, **20.2.5**.

18.3 Construction of fire-fighting shafts

Fire-fighting shafts should be constructed in accordance with BS 9999:2017, **20.3**.

Where computational fluid dynamics (CFD) analysis is undertaken to verify the design of smoke control systems in areas adjacent to those protected by a pressurization system(s), this analysis should take into account the interaction with the adjacent pressurization system(s).

*NOTE CFD analysis is suggested in BS 9999:2017, **20.3.4** as providing suitable evidence of satisfactory smoke control performance in the absence of a pressurization system. For sub-surface stations and intervention shafts, as pressurization is always required (see **18.2.1**), it is not necessary to undertake additional CFD analysis.*

18.4 Firefighters lifts

The provision and installation of firefighters lifts should be in accordance with BS 9999:2017, **20.4**, with the following exceptions.

a) Sub-surface railways often have large height differentials between floors, and therefore means to provide rescue of trapped occupants should be provided.

   NOTE 1 One suitable method would be to provide anchor points to enable rope access to rescue trapped occupants of lift cars where a blind shaft exceeds 7 m between access points into the shaft (as permitted in BS EN 81-72:2015). Further guidance is given in Annex B.

b) If it is proposed to use firefighters lifts in railway infrastructure for movement of plant and equipment, e.g. for railway engineering during non-traffic hours, this needs to be controlled under the infrastructure operator's procedures, and should be discussed with the relevant fire and rescue services at the earliest design stage.

c) All firefighters lifts serving sub-surface railway infrastructure should be stretcher-capacity lifts as defined in BS EN 81-72:2015, **5.2.3**, with a minimum rated load of 1 100 kg and minimum dimensions of 1 100 mm wide × 2 100 mm deep.

d) Stations may be served by a single dual-entry firefighters lift, provided that there is signage that clearly indicates the direction in which passengers are to exit the lift, and which indicates the location of the lift to the fire-fighters.

NOTE 2 If a firefighters lift is anticipated to be out of service for any length of time then it is advisable for the relevant fire and rescue services to be notified at the earliest possible opportunity.

19 Vehicle access

Vehicle access should be provided in accordance with BS 9999:2017, Clause **21**, with the following additional recommendations for railway infrastructure.

a) Location information may be provided by alternative means if security considerations necessitate that signage local to the shaft or portal access points not be provided. This should be discussed with the relevant fire and rescue services and other emergency services at the earliest stages of design.

b) Each building within a depot should be treated separately for the purpose of BS 9999:2017, Table 19.

20 Water supplies for fire and rescue service use

20.1 General

If the building comprises sub-surface railway infrastructure, then every part of every qualifying storey should be no more than 60 m from a fire main outlet, measured on a route suitable for laying hose. Fire main outlets should be provided within a fire-fighting shaft in accordance with BS 9999:2017, **20.2**. Fire main outlets should also be provided outside the fire-fighting shafts at 60 m intervals, e.g. on concourses and along platforms, to provide full coverage of the infrastructure.

Fire main outlets should be located on all levels, irrespective of whether a firefighters lift serves that level.

Exact hose distances should be used in all cases within railway infrastructure, where they are known. Where exact hose distances are not known, e.g. in the case of retail areas subject to future fit-out works, direct distances should be taken as two thirds of the hose distance.

It might not be practicable to provide hose coverage to within 60 m of all points within a railway depot building. For such buildings, fire main outlets should be provided adjacent to all fire and rescue service access points. The design and layout of fire mains serving depot buildings should be discussed with the relevant fire and rescue services at the earliest stages of design.

Fire mains that serve stations, intervention shafts or tunnel portal structures should be combined with fire mains serving tunnels.

Fire mains should be designed, installed, commissioned and maintained in accordance with BS 9990:2015, with the exceptions stated in **20.2** to **20.5** below.

20.2 Pre-charged fire mains

It might be necessary to utilize pre-charged (sometimes referred to as “damp” or “pre-filled”) fire mains when long pipework runs could result in excessive fill times. Acceptable maximum fill times from the furthest breeching inlet should be discussed with the relevant fire and rescue service at the earliest stage of design.

Signage for pre-charged mains should be in accordance with BS 9990:2015 for dry fire mains. The terms “pre-charged”, “pre-filled”, “damp” or “hydrant” should not be used on signage at breeching inlets or outlets/landing valves as this could be misunderstood to imply that a wet fire main is provided.

NOTE Fire crews are required to interact with a pre-charged fire main in an identical manner to which they would a dry fire main.

Header tanks used to ensure that pre-charged fire mains remain topped up should be designed such that they do not affect the use of the fire main by the fire and rescue services. Where the top-up facilities are automatic, they should include a non-return valve to ensure that pressurization of the main does not cause water to be vented into the top-up system. When a manual system is used, the main should be isolated from the top-up system once it has been filled.

20.3 Outlet/landing valve type

Double outlets should be provided in any part of railway infrastructure where a second covering/safety fire-fighting jet cannot be connected to an outlet located within a protected fire-fighting lobby or cross-passage within 60 m from the nearest outlet.

NOTE Situations where double outlets should be provided include long station concourses, on platforms or in tunnels.

Each landing valve constituting part of the double outlet should be provided with separate valve isolation wheels rather than a single isolation wheel controlling both landing valves, so that each valve can be independently controlled.

20.4 Pressure regulating valve (PRV)

Wet fire mains should be provided with PRVs in accordance with BS 9990:2015.

NOTE Landing valves forming part of a dry (or pre-charged) fire main are not provided with PRVs. However, in some railway infrastructure where the landing valves are located below fire and rescue service access level, pressures obtained at the fire main outlets can exceed levels that are safe for use by fire-fighters.

Where it is considered that dry fire mains require PRVs to ensure that fire-fighters are not subject to excessive branch pressures, each individual landing valve should be provided with a PRV.

20.5 Drainage facilities

There should be a means of completely draining the fire main without the necessity for dismantling any section of pipework. Where the low points of any pipework cannot be drained via the fire-fighting outlets, separate drainage valves should be installed. Where significant amounts of water are likely to be drained, the drainage points should be served by sumps or drains capable of accommodating that water.

20.6 Signage for fire mains

Signage for fire mains should be in accordance with BS 9990:2015.

20.7 Emergency water supply tanks

*COMMENTARY ON **20.7***

In some remote locations, for example in the vicinity of tunnel portal structures located in rural areas, where hydrant mains might not be available, it can be more practicable to provide an emergency water supply tank(s) rather than installing a hydrant main. In such cases it is of critical importance that the water supply is suitable for the use of the relevant fire and rescue services.

In order to provide emergency water supply tanks rather than a hydrant main, the following recommendations should be met. If these recommendations cannot be met, a hydrant main should be provided.

a) The capacity of the water stored should be sufficient to supply fire-fighting operations for the full duration of the response to a fire incident. As a minimum, the supply should be capable of providing 1 500 l/min of water for no less than 120 min, which requires the provision of a total water storage capacity not less than 180 000 l. This should be discussed with the relevant fire and rescue services and incorporated with the design fire strategy for the infrastructure served.

b) A minimum of two instantaneous couplings conforming to BS 5041-3 should be provided at the low point of the tank not more than 750 mm above finished floor/ground level, in order to enable the fire and rescue service to draw water from the tank. The tank, couplings and any associated pipework should be designed such that the full volume of water required is accessible.

c) A suitably labelled gauge should be located on the exterior of the tank adjacent to the couplings showing the volume of water remaining.

d) Either the tank should be situated within 18 m of the tank couplings from the vehicle access roadway, with parking provided, or hardstanding for at least one fire and rescue service pumping appliance should be provided within this distance.

Where practicable, the water supply arrangements should be in accordance with BS 9999:2017. Where this is not practicable, the relevant fire and rescue services should be consulted at the earliest stage of design.

In remote rural areas where the water supply arrangements include the use of fire and rescue service water tanker appliances, the response arrangements should be discussed and agreed with the relevant fire and rescue services at an early stage.

20.8 Isolating valves for tunnels

NOTE General recommendations for tunnels are given in Section ***6****.*

Where isolating valves for tunnel fire mains are provided within station buildings in accordance with BS 9990:2015, **4.1.1**, these should be located within protected fire service access routes (preferably within fire-fighting lobbies). Clear and conspicuous signage indicating the parts of the system that are isolated by the valve should be provided. Isolating valves in tunnels should also be provided with signage to identify the sections of fire main isolated (for example, using the wording “THIS VALVE ISOLATES THE NEXT 180M SECTION OF FIRE MAIN TOWARDS [LOCATION X]”).

In tunnels, isolating valves should be located at intervals not exceeding 180 m (one isolating valve for each group of three landing valves).

The location of any isolating valves located within the station or intervention shaft should be identified on the premises fire plans and referenced in the legend. A note should be provided on the plans in each instance where isolating valves are identified, stating the section of main that is isolated by the valve.

The following information should also be included on the premises fire plans.

a) The locations of all fire main breeching inlets should be identified. This should include details of where the main can be charged from a breeching inlet at an alternative location, e.g. the next station on the line or an intervention shaft.

b) When system coverage ends at the next station or intervention shaft, the plan should state where the inlet to charge the next section of fire main is situated (e.g. “SYSTEM COVERAGE ENDS AT STATION B. INLETS TO CHARGE SECTION BETWEEN STATION B, SHAFT C AND STATION D ARE LOCATED AT STATION B, SHAFT C AND STATION D”), unless all inlets can be used to charge all parts of the infrastructure.

c) Where separate breeching inlets supply different parts of the premises, this should be clearly identified. Wherever practicable, the fire main serving the station or intervention shaft should also serve adjacent sections of tunnel.

21 Communications systems for fire and rescue service use

COMMENTARY ON CLAUSE ***21***

In order to enable the fire and rescue services to undertake effective fire and rescue operations and to enable safe systems of work to be implemented, it is essential that fire and rescue service personnel can communicate *with each other throughout the duration of an incident without interruption. It is essential that adequate communications are provided to ensure both point-to-point and multi-agency communications.*

21.1 General

Consultation regarding the specific requirements for the overall design should be undertaken with the relevant fire and rescue service at the earliest stage of design.

A means should be provided for checking that any leaky feeder or antenna system provided to extend radio coverage within a building/infrastructure is functioning, and for indicating when the system is unavailable due to a fault.

NOTE 1 This may take the form of an indicator panel located with a station control room or adjacent to the fire alarm panel within an intervention shaft head house.

Any such indicator panel should be clearly labelled as to its function, and should identify a fault with communication equipment by an amber LED and audible warning buzzer. The labelling to the LED should clearly indicate to fire and rescue service personnel that radio coverage is not available and to which parts of the building/infrastructure being accessed this applies.

If remote status indication is provided at the infrastructure operator’s central control facility, e.g. to monitor an unstaffed location such as an intervention shaft, the infrastructure operator’s procedures should include a means for the relevant fire and rescue services to be notified immediately when radio coverage is not available.

Any fire telephone/emergency voice communication system should be in accordance with BS 5839-9.

NOTE 2 This is not the same as the lift communications system described in BS EN 81-72:2015.

21.2 Stations

In all railway stations and terminus buildings, whether surface or sub-surface, a reliable means should be provided of communicating to and from fire and rescue personnel entering the building to all areas where fire-fighting crews can be reasonably expected to operate, including the extension of coverage to fire appliance rendezvous points (RVPs) and hardstanding locations. Communications should be compatible with the relevant fire and rescue services’ existing communications equipment.

Communications provision should be of a nature that affords seamless communication in all areas of the railway as if the whole infrastructure were located in the open.

21.3 Tunnels, escape and intervention facilities

*NOTE 1 General recommendations for tunnels are given in Section **6**.*

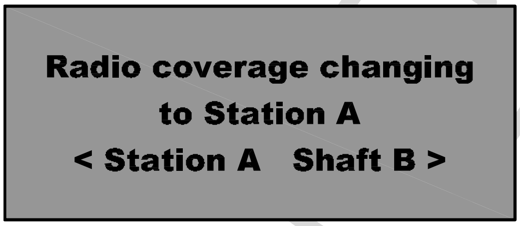
In railway tunnels, escape shafts, intervention shafts and associated areas, communications should be provided between those areas and the surface access points for fire and rescue service personnel. Communications should be compatible with fire and rescue services’ communication strategy. Where infrastructure is shared between different fire and rescue services, early agreement should be obtained regarding the combined communication to be used.

Communication provision should be of a nature that affords seamless communication in all areas of the tunnel, intervention point/shaft, escape point/shaft and associated areas as if the whole area were located in the open.

In infrastructure where radio coverage to a section of tunnel between intervention points is provided by more than one leaky feeder or antenna base station, signage should be provided to indicate to fire crews working in the tunnel when they are moving from one base station area/zone of coverage to another, as this has an impact upon safe systems of work and necessitates that a communications officer and breathing apparatus entry control point be established at the adjacent intervention point. There should be an overlap of approximately 5.0 m between areas/zones of coverage. Mid-point/overlap signage should be provided in both tunnel bores (or, in the case of bi-directional tunnels, on both sides of the tunnel), affixed to the tunnel walls at between 1.0 m and 1.4 m above the walkway floor level, stating that radio coverage is changing to an adjacent area/zone of coverage and visually indicating the direction in which the adjacent intervention points (stations, shafts or portals) are located. In twin-bore tunnels, the transition point between base station areas/zones should be located at a cross-passage such that the cross-passage is entirely covered by only one of the adjacent base station areas of coverage.

NOTE 2 Figure 1 shows an example of mid-point/overlap signage.

Figure 1 – Example of mid-point/overlap signage



Full discussions on the specific requirements for the building/infrastructure should be undertaken with the appropriate fire and rescue service at the earliest stage of design.

21.4 Fire control centre

Fire control centres should be provided in accordance with BS 9999:2017, Clause **24**, together with the following additional recommendations.

A fire control centre (which may form part of the station operations/control room) should be provided in all sub-surface railway stations, and all large and complex surface railway stations, to enable the infrastructure operator to assist the fire and rescue service in managing an incident. The fire control centre should be either:

a) a room dedicated solely as a fire control centre; or

b) combined with the management central control room or station control room.

The fire control centre should be situated adjacent to a fire and rescue service access point, or other location agreed with the fire and rescue service, and it should be readily accessible, directly from the open air where practicable. If this is not practicable, the route to the fire control centre should be protected with 2 h fire-resisting construction and designed and constructed as a protected route. Services run within the route to the fire control centre should comprise only those associated with the protected route, fire control centre and station operations/control room. In all cases, the fire control centre and the station operations/control room (if separate) should be clearly identified on premises plans provided for fire and rescue service use.

Because of the possible need for the fire control centre to be operational for an extended period of time, it should be separated from the remainder of the building by 2 h fire-resisting construction and should incorporate facilities to enable it to function as normal during an emergency.

22 Drawings for fire and rescue service use

Drawings for fire and rescue service use should be provided in accordance with BS 9999:2017, Clause **26**, together with the following additional recommendations.

Additional copies of these drawings should be offered to the fire authority to enable planning for an emergency.

Plans of the premises suitable for use by fire-fighters when attending the premises for fire-fighting purposes should be kept in a part of the premises that is immediately accessible to fire-fighters.

A premises information box should be located at, or within sight of, the RVP, and it should be maintained with the current applicable drawings, including any temporary changes due to construction or prolonged maintenance activities. The arrangements for access to the box during a fire emergency, and its contents, should be agreed with the relevant fire and rescue services.

Premises information boxes for buildings (or sites with multiple buildings) such as railway depots should be situated as close as possible to the entrance to the site, e.g. at a security gate house, in order to assist the fire and rescue service with determining where to locate appliances.

23 Heat and smoke control

23.1 Smoke ventilation of fire-fighting shafts serving sub-surface railway infrastructure

Heat and smoke control should be provided in accordance with BS 9999:2017, Clause **27**, except that fire-fighting shafts in sub-surface railway infrastructure should be provided with pressure differential smoke control systems only.

Any system provided should be configured such that it does not rely upon the fire and rescue service for operational control.

Pressure differential systems for fire-fighting purposes should be designed and installed in accordance with BS EN 12101-6:2005, Class B systems.

23.2 Venting of smoke and heat from enclosed stations, including sub-surface stations

For enclosed stations, including sub-surface stations, heat and smoke control should be provided in accordance with BS 9999:2017, Clause **27**. Where the accommodation is located in a basement and a mechanical smoke venting system is used, this should be sprinkler-protected in accordance with BS 9999:2017, except where the materials in those locations are in accordance with **37.2** of the present standard, in which case sprinklers do not need to be provided.

24 Isolation and earthing of traction power

*COMMENTARY ON CLAUSE **24***

For electrified railways, whether served by catenary/overhead line equipment or third/fourth rail traction power systems (or both), in order for the fire and rescue services to establish safe systems of work for both their own personnel and other emergency responders, it is critical that procedures be developed for the isolation of traction power in the event of an incident. These procedures generally follow nationally agreed protocols and operational guidance.

Procedures for isolation of traction power and discharge of residual power by earthing (where applicable) should be discussed between the infrastructure operator and relevant fire and rescue services prior to the electrification of the infrastructure. This should include protocols for communication between those able to confirm that the power supplies have been isolated, and the fire and rescue service control room. Where it is required that the infrastructure operator’s suitably trained personnel attend to effect the discharge of residual current, this should be incorporated into emergency response plans.

NOTE It cannot be assumed that fire service personnel can operate equipment to isolate and/or earth traction power prior to the commencement of their fire and rescue activities. It is the responsibility of the railway operator to complete the necessary procedures and to issue swift, reliable and unambiguous assurance to the fire service that any requested section(s) of current-carrying conductors have been made safe.

25 Access and facilities for specific types of railway buildings or infrastructure

25.1 Bridges and viaducts

*COMMENTARY ON **25.1***

Bridges and viaducts present difficulties for fire and rescue services in that access is likely to be available only from either end of the structure, and this access is likely to be constrained. The provision of access to a point as close as possible to the ends of the bridge or viaduct, as well as facilities such as fire mains, can reduce the time required for fire-fighters and other emergency responders to reach an incident, and ensure that safe systems of work can be implemented.

The recommendations in this subclause should be met as far as is practicable. Where it is not possible to meet these recommendations due to the design of the structure or the nature of the area being crossed, all relevant fire and rescue services should be consulted at the earliest possible opportunity.

Access for fire and rescue service appliances should be provided to within 18 m of both ends of any railway bridge or viaduct where the length exceeds 500 m, or to one end only if the length is less than 500 m. Where the length of a bridge or viaduct exceeds 3 000 m, a further access point should be provided to the mid-point.

Where the access road exceeds 20 m in length, suitable turning facilities should be provided for fire and rescue service vehicles in accordance with BS 9999:2017, **21.3**. Sufficient hardstanding should be provided to allow fire and rescue service vehicles, as well as other emergency vehicles such as ambulances, to park. Where practicable, a layby or parking area should be provided to enable coaches to collect passengers and staff who have to be evacuated from trains.

An access walkway should be provided running the full length of a bridge at track level. The width of access walkways should be not less than 800 mm and suitable guarding should be provided for fall prevention.

Where the length of a bridge or viaduct exceeds 1.0 km between fire service access points, a fire main should be provided to the walkway with breeching inlets located within 18 m of fire service access points at each end, double landing valves located at 60 m intervals and isolation valves located at 180 m intervals. Fire mains should be designed in accordance with BS 9990:2015 and Clause **20** of the present standard.

25.2 Cuttings

*COMMENTARY ON **25.2***

A cutting in railway infrastructure is a permanent excavation with sloped sides such that the track, or permanent way, is situated below the level of the surrounding fire service access level.

Cuttings present an obstacle to the fire and rescue services and other emergency responders in gaining access to the railway in order to undertake fire-fighting, rescue and emergency medical operations in the event of fires and other incidents. Without additional access points being provided, significant delays can be experienced in reaching an incident, even where the incident occurs in close horizontal proximity to the roadway. Access points provided for use by the emergency services also serve to enable evacuating passengers and staff to reach a location outside of the railway infrastructure. This is particularly important where cuttings are located in remote, rural areas and uninjured passengers cannot continue their journeys unassisted.

Where the distance between level access points to a railway cutting exceeds 1.0 km, the following recommendations should be met as far as is practicable. Where it is not possible to meet these recommendations (e.g. due to the surrounding geography/geology, or due to the cutting being situated within a protected location such as a National Park or protected moorland), all relevant fire and rescue services should be consulted at the earliest possible opportunity.

a) Where practicable, a roadway suitable for fire and rescue service vehicles should be provided adjacent to the cutting on at least one side, and stairs should be provided as access points at intervals of not less than 1.0 km.

b) The access stairs should extend to track level, with a width between the walls or balustrades of not less than 1.1 m and designed in accordance with BS 5395-1. The stairs do not need to be enclosed, but where they are enclosed, the width should be maintained clear for a vertical distance of 2.0 m, measured from the pitch line or landing floor level, with the following exceptions:

   1) stringers, each intruding into the stair not more than 30 mm; and

   2) handrails, each intruding into the stair not more than 100 mm.

c) External water supplies should be provided in accordance with BS 9999:2017, **22.2**, with hydrants or other suitable water supplies provided to within 90 m of the top of the access stair.

The design of access and facilities to new railway cuttings should be discussed with the relevant fire and rescue services, as their available resources and standard operating procedures might necessitate the provision of additional facilities such as fire mains within cuttings, vehicle access to track level or a reduced distance between access stairs.

25.3 Tunnels and intervention/escape shafts

Access and facilities for fire and rescue services in tunnels and shafts should be in accordance with Section **6**, with the exception of communications systems, which should be in accordance with **21.3**.

Section 6: Tunnels and viaducts

*COMMENTARY ON SECTION **6***

The Technical Specification for Interoperability – Safety in Railway Tunnels (TSI-SRT) *[6] for the interoperable rail system of the European Union sets out the requirements for fire safety in railway tunnels over 100 m up to 20 km in length. The recommendations in this British Standard supplement the information in the TSI.*

The requirements of the TSI-SRT, and other legislation current at the time of the publication of this British Standard, are mandatory for all tunnels on the UK mainline railway system. Certain tunnels within the UK (notably London Underground) are not required to be interoperable, but it is considered as good practice to apply the principles of the TSI-SRT to all tunnels. This British Standard is applicable to all railway tunnels, regardless of whether they are required to be TSI-compliant. This includes metro tunnels, commuter rail tunnels, high speed tunnels, freight tunnels, tunnels formed within stations (i.e. platform tunnels.)

The recommendations within this British Standard do not preclude the authority having responsibility for any tunnels imposing more onerous requirements for their tunnel if required in relation to specific hazards or for the purposes of asset protection and maintenance of business continuity.

26 General recommendations for tunnels and viaducts

26.1 Tunnel design

New tunnels longer than 100 m, extensions of existing tunnels such that the combined length exceeds 100 m, all extensions that connect existing tunnels to new sub-surface or covered stations, and the overbuild of any existing station that forms a tunnel longer than 100 m on any side of the station should be built in accordance with the recommendations for new tunnel design as described in this British Standard and/or the relevant TSI as appropriate.

Extensions of existing tunnels where the combined total length between stations (or where there are no stations between portals) of the new and existing tunnel exceeds 3 km should be provided with an intervention point located as close as practicable to the connection to the existing tunnel.

Extensions of existing tunnels that directly connect to a sub-surface or enclosed station(s) should be provided with an intervention point either in the form of facilities shared with the sub-surface or covered station or a separate shaft.

NOTE If the existing tunnel meets the recommendations in this British Standard, the position of the first intervention point of the new tunnel may be varied to satisfy the recommended spacing for the existing tunnel.

Any existing operational procedures should be updated to cover any new tunnel section.

26.2 Operational principles

The priority should be for any train on fire either to stop at the next station, or to leave the tunnel and reach the nearest station or other location where passengers can more quickly reach a place of ultimate safety and where fire and rescue services have better access to approach the incident.

For incidents that cause or require the train to stop within a tunnel, one of the following procedures should be implemented.

a) For single-track tunnels, or multi-track tunnels with a protected route to the place of ultimate safety, the train should attempt to stop in such a position that the front of the train overlaps a tunnel cross-passage (preferably near a ventilation shaft) or a lateral exit to the protected route.

b) For multi-track tunnels, the train should attempt to stop aligned with any features that could offer improved tenability or access.

A member of the train crew should be in communication with the railway control room to allow both the location of the fire on the train and the train stopping location to be understood by both parties.

NOTE This information may be supplemented by automatic systems.

Accurate train stopping information should be automatically provided to the railway control room for trains without crew.

Accurate fire location information should be automatically provided to the railway control room for trains without crew. For trains with crew, the fire location information should be supplemented with verbal confirmation by the train crew.

For trains without crew, methods should be provided and demonstrated that allow for passengers to evacuate the train and reach a place of ultimate safety in the absence of train crew.

26.3 Minimum operating parameters

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

NOTE 1 Failures of systems and equipment might result in operators operating the railway at an increased level of risk for a short duration.

The operating parameters should take into account as a minimum which facets of the tunnels and tunnels systems should 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, and agreed with the infrastructure operators and fire and rescue services at the outset of the project.

NOTE The minimum operating parameters 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 would not likely to be acceptable for an entire tunnel lighting system to be known to be non-operational during any train service.

The minimum operating parameters analysis should categorize types and extents of system failures, and should define the maximum permissible duration for any failure beyond which it will be deemed that there is insufficient functionality for the railway to continue operations.

Such analysis 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.

Stakeholders should be consulted to establish how the minimum operating parameters are to be accommodated in the design and operation of the tunnel. The results of this consultation should be documented.

27 Ventilation and smoke control systems

27.1 General

Tunnels should be provided with ventilation and smoke control systems to maintain a tenable environment for the evacuation of passengers and train crew, and to aid fire-fighting and rescue operations.

27.2 Single-track tunnels

For single-track tunnels, any train in front of the incident train should be driven out of the tunnel or to the next station. Any train following the incident train should be automatically prevented from entering the incident train’s ventilation zone.

If the front of the train overlaps a cross-passage/lateral escape route, the tunnel ventilation system should be operated to move air forwards (in the direction of train travel). For compartmented trains, end door evacuation might be preferred, and passengers should be instructed to evacuate from the train doors nearest to the cross-passage into a place of relative safety created in the adjacent non-incident tunnel. For non-compartmented trains, evacuation using all available side doors might be preferable, and passengers should be instructed accordingly.

NOTE 2 Air flowing through the open cross-passage potentially provides a locally more tenable environment once the cross-passage doors are open.

If the front of the train does not overlap a cross-passage, the ventilation airflow direction should be chosen based on protecting the greatest number of passengers from exposure to smoke.

Any tunnel ventilation system should provide a control and monitoring system providing predefined ventilation responses to fire scenarios. A decision support system should be provided to assist any staff in effectively determining the direction of airflow. In the event of a failure of a member of staff to select the ventilation direction, a default direction should be provided, which is normally to ventilate forward. The decision as to which direction to operate should be made by control room staff, informed where possible by direct dialogue with members of the train staff.

27.3 Multi-track tunnels

For multi-track tunnels, alternative measures should be provided, which should be determined on a case-by-case basis.

NOTE 1 Examples of such alternative measures include:

- *a ventilation system that naturally or mechanically allows for smoke to be removed from high level within the tunnel, such that a locally tenable environment is provided below the smoke for passengers to evacuate through;*
- *a ventilation system that provides localized high capacity exhaust, such that a tenable environment is provided on either side of the exhaust point;*
- *a ventilation system that limits the air movement to allow for stratification in the incident tunnel, combined with additional cross-passages/lateral exits at a spacing which is shorter than the length of the shortest train.*

In such scenarios the ventilation system can be operated either automatically or by the control room staff.

NOTE 2 Such alternative measures may also be adopted for single-track tunnel, subject to demonstrating that the hazards to passengers would be no greater than that for single-track tunnels that operated with a limitation of one train per ventilation zone and a tunnel ventilation system capable of being used in either forwards or backwards ventilation.

27.4 Ventilation zones

Only one train should enter a single ventilation zone at any time, to allow for the possibility of ventilating the incident train in either the forward or the reverse direction, and to avoid potentially exposing any passengers in a following train to smoke. The train signalling design should be coordinated with the ventilation zones.

Multiple trains should not be permitted within a ventilation zone unless it can be demonstrated that the hazard of smoke exposure to passengers, staff and the fire and rescue services is no greater than that for the situation of one train per ventilation zone. The following train should not be reversed unless the following conditions can be met.

a) The traction power system should be capable of being de-energized within the section occupied by the incident train, and should remain energized or be re-energized to allow reversal of the following train.

b) The reversal of the train should be achieved prior to any smoke reaching the following train, accounting for the ventilation system directing air against the direction of train movement and towards the following train.

c) The signalling system design, the operational procedures and the rolling stock in combination should be capable of reversing the following train in the available time before smoke exposure.

A successful demonstration of the reversal of a train in the required time before smoke would affect the following train should be made prior to accepting it into use on the railway.

27.5 Ventilation design criteria

Tunnel ventilation should be provided to:

a) maintain a tenable environment upstream of the fire in the incident tube (accepting that for longitudinal ventilation systems tenability might not be achieved downstream of the fire); and

b) maintain a tenable environment in the non-incident tube such that it can be used as a place of relative safety for evacuating passengers and as an intervention route for the fire and rescue service.

In order to achieve a tenable environment, the following criteria should be met.

1) For longitudinal ventilation systems, the air velocity in the annular area between the tunnel and the train should be sufficient to prevent back layering of smoke.

2) Air velocities within tunnels and along escape routes should not exceed a maximum of 15.5 m/s.

3) Air velocities within tunnels should not slow passenger movement to the extent that the maximum permitted evacuation time is compromised.

4) The ventilation system should be capable of meeting the tunnel environment criteria with cross-passages/lateral exit doors closed and open.

5) Air velocities through open cross-passage doors should be sufficient to prevent smoke from entering the place of relative safety, and should be maximized to allow the airflow to create a local area of improved tenability between the train and the open cross-passage doors.

6) The thermal environment upstream of the fire in the incident tunnel and in the place of relative safety should not exceed a wet bulb globe temperature of 32 °C when calculated in accordance with BS EN ISO 7243:2017.

7) The carbon dioxide concentration upstream of the fire in the incident tunnel and in the place of relative safety should not exceed the prevailing national long-term occupational exposure limits.

8) The ventilation system should be resistant to meteorological effects (i.e. wind forces and barometric pressure differences) not likely to be exceeded for more than 1% of any year.

Tunnel ventilation systems and equipment should:

i) include redundancy to enable operation of the ventilation system to continue reliably during a fire emergency;

NOTE 1 A standby fan and associated equipment within each ventilation shaft or fan room would normally be sufficient to provide adequate redundancy.

ii) include sufficient thermal resistance[5)] to ensure that the system can manage the smoke temperatures that would be expected for the duration required for passengers to leave both the incident and non-incident tunnel bores;

iii) be provided with sound attenuation, if required, to prevent noise levels in the tunnel from exceeding 85 dB(A);

[5)] Guidelines for thermal performance are given in the withdrawn publication CEN/TR 12101-5.

iv) be provided with sound attenuation, if required, to allow the fans to be regularly tested without the risk of a defensible noise complaint from nearby residents as determined using the methods outlined in BS 4142; and

v) be provided with an automatic control system with a safety integrity level not less than SIL 2 as defined in BS EN 61508-1:2010.

NOTE 2 Where the tunnel ventilation system connects or interfaces with a fire detection and fire alarm system, that fire detection and fire alarm system is not required to have a safety integrity level if the fire alarm is provided in accordance with BS 5839-1:2017.

28 Means of escape from tunnels and viaducts

28.1 General

In the event of a fire in a tunnel, passengers should be able to self-evacuate into a place of relative safety and then to a place of ultimate safety. Tunnels and associated shafts are not usually staffed, so the means of escape should be designed such that passengers can use it unassisted. If lifts are used for evacuation from these locations, then the use of these should either be assisted by train-borne personnel, or there should be a robust plan for staff to reach the premises and complete the evacuation.

Access to the place of ultimate safety should be via an escape walkway to one or more of the following escape facilities:

- an adjacent station;
- an adjacent intervention and escape shaft;
- a rescue train;
- a rescue station to await a rescue train.

For single-track tunnels, the place of relative safety should be the adjacent non-incident tunnel or a separate intervention tunnel (as, for example, in the Channel Tunnel), unless remaining in the incident tunnel presents a more favourable evacuation route.

NOTE 1 For example, if the incident is close to a station it might be more expedient for passengers upstream of the fire to remain in the incident bore and travel directly to the nearby station.

For multi-track tunnels, the place of relative safety should be created either within the incident bore or by providing a protected escape path or rescue area.

For all multi-track tunnels, an analysis should be carried out to verify that the resulting level of risk to passengers and fire and rescue services is likely to be no greater than for a single-track tunnel of similar length, with passengers evacuating into either the non-incident tunnel or a separate escape tunnel.

A place of relative safety should have at least one means of egress to a place of ultimate safety.

An evacuation analysis should be carried out for all tunnels and viaducts to verify that the time for any passenger to reach the place of ultimate safety does not exceed 2 h from the moment that the passenger disembarks the train. This analysis should be based on the following criteria and assumptions.

a) For walkways less than 1.3 m wide, the walking speed should be based on that of PRM and assumed to be 0.63 m/s (38 m/min).

b) For walkways 1.3 m or wider, it should be assumed that some passengers are likely to overtake others, and the average speed of these persons may be assumed to be to be 1.2 m/s (78 m/min); however, the evacuation should still account for the walking speed of PRM.

c) The time taken to disembark and, if rescue trains are to be used, to embark into the rescue train should be established taking into account the type of rolling stock, number of exits and passengers.

d) The time taken for a rescue train to be mobilized and reach the required stopping location should be established with the railway operator, including any reduced rescue train speeds that might be required to prevent compromising the performance of any tunnel ventilation system.

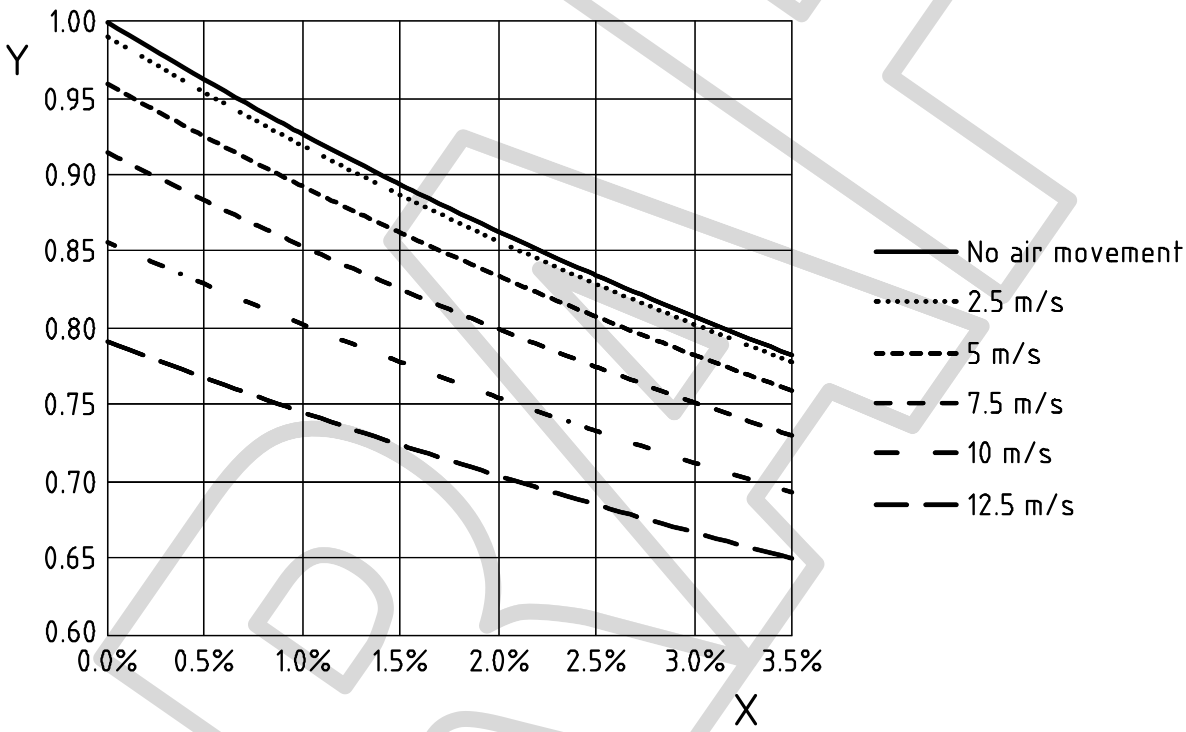
e) The impact of gradient and air movement in the place of relative safety should be accounted for based on the correction factors shown in Figure 2.

NOTE 2 For example, at 2.0% gradient and 10 m/s air speed, the correction factor from Figure 2 would be 0.75. The walking speed for a 1.3 m wide walkway would be corrected to 0.75 m/s × 1.5 m/s = 1.13 m/s.

f) Where two or more escape routes converge, the flows should be added together.

NOTE 3 The walking speed can be affected by gradient and the air velocity within the tunnel.

Figure 2 – Correction factors for air movement and gradient



Key

X Walking gradient

Y Correction factor for normal walking speed

28.2 Tunnel and viaduct walkways

Obstruction-free walkways should be provided for evacuation and fire-fighting. These should be a minimum of 0.85 m wide and have a 2.25 m vertical clearance above the walkway.

The position of the walkway should be commensurate with the layout of any existing infrastructure and the rolling stock. Where practicable and compatible with the infrastructure and rolling stock, walkways should be level with the floor of the rolling stock.

Cant and railway clearances can create a large gap between the walkway and the train, and should be accounted for in the evacuation process.

NOTE This might require additional equipment to be available on trains, particularly for PRM. The way in which wheelchairs are manoeuvred from the train onto the walkway and then turned on the walkway also needs to be taken into account.

The design should be such that the operational procedures for managing evacuation of PRM to walkway are achievable.

After leaving the train, all walkways and routes from the incident should be step-free, to facilitate the evacuation o f PRM unable to negotiate steps and stairs.

Irrespective of the location of the walkway used for escape, an additional walkway at least 0.45 m wide and opposite the escape walkway should be provided to allow fire and rescue services access to the undercar of the train.

Level access should be provided through cross-passages and into stations and intervention shafts.

Ramps should be provided between walkways and station platforms.

The gradient for any ramp between a platform and a walkway should not exceed 1:12.

28.3 Tunnel escape facilities and shafts

Escape stairs should have a staircase width not less than 1 200 mm between handrails.

Escape stairs should be provided with rest areas not less than 2 m^2 every other landing.

Escape stairs should include a refuge area at the base of the stair suitable for use by PRM and located such as not to impede access by fire-fighters.

Refuge areas should be capable of holding:

a) the maximum number of wheelchair users that can be accommodated on the rolling stock that is expected to operate through the tunnel ; and
b) not less than 2.5% of the evacuation capacity of the rolling stock (see **14.7**) at a passenger density of not greater than two persons per square metre.

All equipment rooms within shafts should have 60 min fire resistance with respect to integrity and insulation as determined in accordance with BS EN 1992-1-2.

The non-public areas of any buildings located on the surface immediately above the shaft should be designed in accordance with BS 9999:2017. The fire resistance of the walls and doors protecting the means of escape should be not less than 2 h.

28.4 Tunnel cross-passages

Twin-bore tunnels should have cross-passages between the tunnel bores.

Single-bore tunnels should have doors to a protected exit.

The distance between cross-passages/doors should not exceed 500 m.

NOTE The spacing between cross-passages might need to be less than 500 m to satisfy the maximum escape time criterion or allow for any ventilation provisions. A spacing less than 500 m might also be needed in situations with longer trains where, for example, a shorter spacing might allow both ends of the train to access a cross-passage.

Cross-passages should be at the same level as the walkway and allow for wheelchair use. The gradient within a cross-passage should be not greater than 1:20 and should never exceed 1:12.

Cross-passages should provide a minimum of 1.5 m clear width and 2.25 m clear height, for passenger egress.

Where cross-passages are used to house tunnel equipment, they should be provided with fire detection and provided with a compartmentation with at least 60 min fire resistance between the cross-passage and either of the running tunnel tubes.

Self-closing fire doors should be provided at cross-passages. The combined fire integrity of the doors between the running tunnel or between the incident tunnel and a protected cross-passage should be not less than 120 min.

Cross-passage doors should not protrude into the walkway to the extent that the minimum escape walkway width is compromised.

The opening force for any cross-passage door should not exceed 220 N.

Cross-passage doors should be capable of meeting their performance requirements for their service life accounting for the flows and pressures generated by train movement.

Cross-passage doors should have a minimum clear opening of 1.5 m wide × 2.0 m high.

28.5 Tunnel signage

NOTE 1 Attention is drawn to the Health and Safety (Safety Signs and Signals) Regulations 1996 [7] in respect of emergency and safety signs.

Signage should be provided to indicate the position of any emergency equipment within the tunnel. Fixed exit signs should be provided to indicate both the distance and directions to exits, cross-passages and portals.

Emergency signage should conform to BS ISO 3864-1.

Safety signs should conform to BS EN ISO 7010.

Fixed exit signage within the tunnels should be in accordance with Railway Group Standard GI/RT 7033 sign type BB01 [N1], modified to suit the types of and relevant distances and structures.

Fixed exit signs should be marked in a manner that is clearly visible, so that evacuees can readily identify and determine the most appropriate and direct route to a place of safety.

The lighting in the vicinity of cross-passages should be sufficient to enable people to find the cross-passage readily in the event of a fire or smoke emergency.

NOTE 2 Further guidance is given in PIARC publication 2016R06EN [8].

28.6 Tunnel emergency lighting

Emergency lighting in tunnels should meet the following recommendations.

a) Emergency lighting should be provided in accordance with BS 5266-1.

b) Emergency lighting should be capable of being remotely controlled from the railway control centre.

c) The default status of emergency lighting should be off.

d) Emergency lighting should be capable of being activated locally by switches located:
   - at intervention/ventilation/escape shafts;
   - at cross-passages;
   - midway between cross-passages;
   - at tunnel head walls and portals.

e) Manual lighting switches should incorporate reflective signage to indicate the function of the switch, and self-illumination to indicate the location of the switch.

f) Cabling serving tunnel lighting should be category 3 in accordance with BS 8519.

g) High-reliability low-voltage power supplies should be provided to support tunnel lighting such that the system can operate during a fire emergency.

NOTE This does not mandate the use of battery-backed uninterruptable power supplies if high reliability alternative power supplies are provided; however, an uninterruptible power supply might still be required to *provide power for the period where any power supply system is reconfigured in the event of failure of a primary feed.*

28.7 Tunnel fire detection and fire alarm systems

Tunnels should not normally be provided with fire detection and fire alarm systems within the tunnel bores, unless such systems are specifically required for the tunnel emergency ventilation control system.

Where a fire detection and fire alarm system is used in a tunnel, it should be demonstrated as being suitable for a tunnel environment.

NOTE Airflows can be high in a tunnel, and thus detection might more challenging due to the resulting dilution of heat. Contamination from dusts might cause false alarms for some detection technologies.

A means should be provided for the control centre to be alerted to the location of a fire as detected by any on-board rolling stock fire detection system, and for this information to be made available to any operator of any tunnel fire detection system when selecting the appropriate ventilation mode.

Cross-passages that accommodate equipment that serves the tunnel should be provided with a Category P2 and L4 fire detection and fire alarm system in accordance with BS 5839-1:2017.

Any cross-passage fire detection and fire alarm system should provide remote indications of fire detection and the fire detection system health status. A CCTV system should be provided to allow remote verification of any fire alarm, and the fire alarm and fire detection system should be capable of receiving and acting upon a remote reset command from the railway control centre.

29 Tunnel fire resistance

The fire resistance of tunnels with passenger-only traffic should be not less than 120 min with respect to stability and integrity of the tunnel lining. The fire resistance of the tunnel lining should be tested using the ISO 834 time–temperature curve.

The fire resistance of tunnels with freight traffic should be not less than 120 min when tested in accordance with the EUREKA time–temperature curve, unless there are appropriate mitigating measures.

NOTE 1 The EUREKA time–temperature curve is described in Rail Industry Guidance Note GIGN7619 [9].

NOTE 2 Appropriate mitigation measures might include an automatic fixed fire suppression system for the engine and freight compartments, to reduce the likely heat release rate to a value equal to or lower than that for passenger-only rolling stock.

Critical fixings and services should include measures to maintain their integrity during a fire.

NOTE 3 Fixings and services are deemed to be critical if their failure could compromise the integrity of fire and life safety systems that need to remain functional during any evacuation or intervention, or would result in an additional hazard to the fire and rescue service. Measures that can be taken to maintain system integrity during a fire include providing redundant and supplementary fixings, or fixings that are designed to maintain their integrity in a fire scenario.

30 Access and facilities for fire-fighting within tunnels

30.1 Tunnel intervention facilities

Intervention facilities should be provided for the fire and rescue service at tunnel portals, station ends and, depending on the length of the tunnel, at defined intervals along the tunnel. These should be designed as fire-fighting shafts in accordance with BS 9999:2017, with the exception that fire-fighting lobbies at the base of shafts serving tunnels may be larger than the 20 m^2 maximum floor area recommended in BS 9999:2017, **20.2.5**.

Where the fire and rescue services are expected to walk to an incident within the tunnel, the distance between intervention shafts should not exceed 1 km.

If the distance between intervention shafts is greater than 1 km, alternative measures to walking should be provided such that it is possible for not fewer than ten fire-fighters to reach the cross-passage/door nearest the incident within 10 min of first reaching the base of the shaft or portal, and that it is possible for crew replacements to arrive regularly thereafter.

NOTE 1 An example of an alternative measure would be the provision of a rail mounted motorized vehicle that fire-fighters can use to carry equipment and personnel to a bridgehead location and then back to the access point.

Intervention facilities should be capable of being used for passenger escape to a place of ultimate safety, regardless of whether other facilities are identified in any evacuation strategy as part of the primary method of passenger escape.

Where practicable, intervention facilities and tunnel ventilation facilities should be located in the same place.

At the point of entry to any intervention shaft, and nearby to a building fire alarm control panel, the fire and rescue services should be provided with a clear visual indication as to the tunnel bore in which the fire is located, and a fixed communications link to the incident controller at the railway control centre.

Building/shaft and tunnel fire alarm systems should interface such that fire-fighters arriving at any shaft are aware that they have arrived at an incident location.

Every intervention shaft head house and tunnel portal structure should be provided with access in accordance with BS 9999:2017, Clause **21** for fire-fighting purposes; associated roadways should be constructed to allow access for fire and rescue service vehicles. Dedicated shaft access points and tunnel portals should be readily identifiable to the fire and rescue service using appropriate signage.

Where practicable, additional information should be provided where it could allow the fire and rescue services to easily understand the situation prior to entering the tunnels.

NOTE 2 Such information could include the location of the trains and the fire, the configuration of the tunnel ventilation system, the energization and earthing status of the traction power system and the open/closed status of any cross-passage doors.

Shafts over 10 m deep should incorporate a firefighters lift conforming to BS EN 81-72:2015 and BS 9999:2017, **20.4**.

Refuges should be accessible to any firefighters lift without the need to re-enter the tunnel tube.

Firefighters lifts should accommodate a stretcher and should have an internal car dimension of not less than 2.4 m × 1.5 m.

Where an intervention shaft connects between the ground level and track level with no intermediate accommodation below ground, the fire-fighting core should be pressurized to 50 Pa.

The fire-fighting core pressurization system should be Class B in accordance with BS EN 12101-6:2005.

NOTE 3 If it can be demonstrated that the tunnel ventilation system, when operated in exhaust, is capable of providing not less than 2 m/s across any single leaf door at tunnel level when a door at ground level is also open, then it does not have to meet any criterion for minimum air velocities across open doors at tunnel level.

30.2 Vehicles for fire and rescue services access within tunnels

Any proposal to adopt vehicles and/or rolling stock for fire and rescue services access should be developed to include a detailed timeline of events, and should be agreed in principle with the fire and rescue service before any adopting any intervention shaft spacing as part of the tunnel's planning or design.

The design of motorized vehicles and the procedures for their use should be agreed with the duty holder and the relevant fire and rescue services at the earliest possible stage of the design.

NOTE This could involve consultation with multiple different fire and rescue services in some instances, for example in the case of a tunnel with portals located in different fire and rescue service response areas.

30.3 Tunnel fire mains

A tunnel fire main system should be provided for all tunnels. The system should be pre-charged with water when the charging time of the fire main exceeds 2.5 min.

NOTE 1 Where the tunnel fire main system runs through an intervention shaft, it is permissible to allow that system to serve any fire-fighting core within the shaft, rather than provide a separate dry falling main within the fire-fighting core.

The tunnel fine main should be in accordance with BS 9990:2015, with the following exceptions.

a) Tunnel fire mains should be designed to deliver 34 l/s (2 040 l/min). A running pressure of (8 ±0.5) bar should be maintained at each landing valve when fully opened.

   NOTE 2 This exceeds the minimum given in BS 9990:2015 and is based upon four landing valves delivering 510 l/min simultaneously, each at a running pressure of (8 ±0.5) bar, as opposed to the recommendation in BS 9990:2015 for 750 l/min from two landing valves simultaneously. This variation is intended to provide the fire and rescue service with the option to approach a train on fire using two separate breathing apparatus teams, each with a primary and a covering/safety jet.

b) Twin landing valves should be provided within the tunnel at spacings not greater than 60 m, with additional section isolating valves at spacings not greater than 180 m. A header tank with a storage volume not less than 1 m^3 should be provided for each charged tunnel fire main.

c) A mains water supply, capable of providing a peak flow of 2 040 l/min, should be provided where practicable. In cases where a mains water supply is not available, a storage tank should be provided that is capable of providing a peak flow of 2 040 l/min and an average flow 800 l/min for a duration not less than 2 h.

d) The lowest point of any storage tank should not be less than 8 m below the ground level where any fire appliance is used to pump the water.

e) A single quad breaching inlet point should be provided common to both tunnel bores. Normally open and locked isolation valves, accessible to the fire and rescue service, should be provided prior to the common inlet connection branching to serve different tunnel bores.

f) The quad breaching inlet point location should be coordinated with the location of the incoming water supply and fire appliance access.

g) Where hydrant main pipework might be exposed to low temperatures, insulation and trace heating should be provided to protect the charged dry fire main and header tanks from freezing.

h) A tunnel drainage system should be provided which should either:

   1) be capable of pumping out the hydrant mains water flow rate at the peak inflow rate of 34 l/s; or

   2) have a combined pumping capacity and storage volume capable of managing a flow of 13.4 l/s for 2 h.

i) Where more than one breaching inlet is provided, local signage should clearly identify the fire main served by each individual breeching inlet point.

Section 7: Railway train care and maintenance buildings

*COMMENTARY ON SECTION **7***

There are numerous railway buildings that require special attention due to the nature of their operations and the internal plant, equipment and rolling stock present.

Buildings containing traction rolling stock are often distinguished from conventional buildings by greater ceiling heights, long un-compartmented structures and the presence of extensive under carriage pits. Consequentially there is an increased chance of a person becoming aware of a fire in the early stages of its development.

Whilst the magnitude of smoke production during a fire cannot be underestimated, due to the nature of processes carried out in these buildings, the main threat to the means of escape is the potential for rapid escalation of the fire and the resultant thermal radiation as a consequence of this.

This section is not applicable to buildings or areas associated with train crew facilities.

31 General recommendations for railway train care and maintenance buildings

The design of train care and maintenance buildings should be in accordance with BS 9999:2017.

32 Risk profile

The risk profile for railway train care and maintenance buildings should be established in accordance with BS 9999:2017, Table 4, taking into account the occupancy characteristics and fire growth rates likely to be present in such buildings.

NOTE Railway operational buildings are generally in occupancy characteristic A, as the occupants can be assumed to be awake and familiar with the building. It is assumed that staff will have undergone an induction to the work place and be aware of emergency exits and fire safety provisions, and that visitors will be escorted at all times. The fire growth rate can vary and is dependent on the plant equipment, storage and operations undertaken. Table 6 lists a range of typical examples for the fire growth rate based on BS 9999:2017, Table 3.

Table 6 – Fire growth rate category examples

Category	Fire growth rate	Typical example
1	Slow	Wheel lathe, under carriage wash, train wash, siding platform, CET siding
2	Medium	Diesel fuelling apron
3	Fast	Workshop/trimming, gas cylinder store

For maintenance sheds with rolling stock present, the fire growth rate should be established in relation to the class of vehicle with the worst hazard level defined in BS EN 45545-2:2013+A1.

*NOTE 3 In general, most areas within train care and maintenance buildings can be designed functionally to meet the recommendations of BS 9999:2017, Clause **11** to Clause **18** inclusive for all risk profiles A1 to A3.*

33 Means of escape from train care and maintenance buildings

If it is necessary for means of escape to pass through long rail vehicles to reach an exit, means should be provided to allow persons to evacuate without being unduly obstructed by the position of train vehicles and the head room available in examination pits.

NOTE 1 Taking rail vehicles into account, the actual length of a train maintenance shed could be in excess of 300 m. Access between train roads is normally limited due to trains berthing and under-carriage examination pits. In under-carriage examination pits, head room can be limited by wheel axles to less than 2 m. Facilities such as access ramps and steps can be provided. Where a swimming pool design is utilized, it might be possible for escape under the train rails providing suitable clearances are provided for personnel to escape under the elevated rails.

For long train vehicle lengths where normal travel distances are not possible, the design should incorporate additional fire protection measures in accordance with BS 9999:2017, Clause **18**.

Every building should incorporate the minimum level of fire protection measures recommended in BS 9999:2017, Clause **15** to Clause **17**. However, if additional fire protection measures are provided as described in BS 9999:2017, **18.2** and **18.3**, it is permissible to increase the travel distance (BS 9999:2017, Table 11) and reduce the door widths (BS 9999:2017, Table 12) and stair widths (BS 9999:2017, Table 13) in accordance with these subclauses, provided that the maximum variations given in BS 9999:2017, **18.4** are not exceeded.

For railway weather-housed process plant and outdoor structures, the recommendations in Annex C should be applied where it is deemed impracticable to meet the full recommendations for means of escape and structural design. The relevant authorities should be consulted at an early stage in order to determine which recommendations are applicable.

Section 8: Signalling control and electrical control centres

34 Control centre facilities

*COMMENTARY ON CLAUSE **34***

Signalling control and electrical control centres are for the purpose of managing signalling and electrical power supplies for the railway infrastructure. They are not the same as station control rooms, station operations rooms or fire control centres to manage alarms, evacuation, etc. for the whole building, for which recommendations are given in BS 9999:2017.

Signalling control and electrical control centres contain a control room, which can be either:

a) a room(s) dedicated as a signalling control room; and/or

b) a room(s) dedicated as an electrical control room.

34.1 Fire and rescue service access

Signalling control rooms and electrical control rooms should be adjacent to a fire and rescue service access point, or other location agreed with the fire and rescue service, and where practicable should be readily accessible directly from the open air. If this is not practicable, access to the control room(s) should be via a protected route with not less than 60 min fire resistance.

34.2 Emergency and standby lighting

Signalling control rooms and electrical control rooms should be provided with a 3 h non-maintained system of emergency lighting, supplied from a source independent of the normal lighting, to enable the control centre to operate satisfactorily in the absence of the normal lighting supply.

Standby lighting should be provided in accordance with BS 5266-1.

34.3 Communications

Signalling control rooms and electrical control rooms should be provided with a reliable means of communicating with the fire and rescue service, in accordance with BS 9999:2017, Clause **23** and Clause **24**.

NOTE Recommendations for fire performance and protection of telecommunications equipment and telecommunications cabling are given in BS 8492.

34.4 Control room equipment

Control rooms should contain:

a) all control and indicating equipment for the fire detection and fire alarm and other fire safety systems for the building. This should include a facility to sound the evacuation signal in each evacuation zone throughout the building, with the ability to signal a total evacuation, unless stairs have been provided to cope only with phased evacuation. A facility to cancel any automatic sequencing of phases of an evacuation procedure except for the initial phase should be provided;

b) control systems that can show the location of an incident and status of all automatic fire protection installations and facilities;

c) override provision associated with all automatic fire protection installations and facilities (other than those that have to be located either adjacent to their equipment or elsewhere where local control is needed, e.g. overrides for gaseous fire extinguishing systems or sprinkler system main or floor isolating valves);

d) override provision for air conditioning systems or ventilation systems involving recirculation;

e) a communication system, conforming to BS 5839-9, providing a direct link between the control room and any refuges;

f) an exchange telephone with direct dialling for external calls;

g) the fire emergency plan for the building;

*NOTE 1 Recommendations for fire routines are given in BS 9999:2017, **43.2**.*

h) keys or other devices required to facilitate access throughout the building and to operate any mechanical and electrical systems;

i) floor plans of the building as described in BS 9999:2017, Clause **26**;

j) facilities to contact principal staff/building services engineers;

k) a clock to time phases of evacuation;

l) a visual indication which can show the status of evacuation in parts of the building where an evacuation signal has been given;

m) a wall-mounted writing board with suitable writing implements for displaying important information.

*NOTE 2 Management responsibilities in respect of general efficiency, staffing and organization of a control centre are outlined in BS 9999:2017, Clause **43**.*

35 Design and construction of control centres

35.1 Fire protection strategy

*COMMENTARY ON **35.1***

The criticality of most signalling and electrical control equipment areas can be categorized subjectively, based on the following factors:

a) equipment redundancy and replacement availability;

b) business continuity plans;

c) tolerance to system downtime.

The output of the risk assessment determines the risk category. The signalling and electrical equipment rooms are likely to be categorized as high or critical due to the dedicated equipment rooms and centralized server/computer facilities.

When determining the fire safety measures required for a control centre, an appropriate risk assessment should first be undertaken in accordance with BS 6266.

NOTE This is not the same as the fire risk assessment for the building associated with fire safety legislation in the UK.

The results of the risk assessment should be used to establish a risk category. This risk category should be used to determine the type and level of fire protection deemed appropriate.

The fire protection systems should be designed and installed as defined in BS 6266:2011.

The risk assessment should be reviewed, and updated as necessary, as changes and modifications are made.

35.2 Means of escape

35.2.1 General

The means of escape from most areas of signalling and electrical control rooms should be designed in accordance with BS 9999:2017.

Signalling control and electrical control centres should be designed to support staged evacuation, to assist the control room personnel to remain in place and bring the operational railway to a safe halt prior to evacuation of the control room.

35.2.2 Fire-resisting construction

All means of escape from signalling control rooms or electrical control rooms should be protected with enhanced fire-resisting construction for a period of not less than 2 h fire resistance and should lead directly from the control room to a place of safety external to the premises.

Where glazing forms part of the fire-resisting construction, this should have an additional rating for insulation.

35.3 Fire separation

Because of the possible need for a signalling control centre or electrical control centre to be operational over an extended period after commencement of an evacuation signal, it should be separated from the remainder of the building by not less than 2 h fire-resisting construction and should incorporate facilities to enable it to function as normal during an emergency.

35.4 Separation and construction of electronic equipment areas

Electronic signalling and supply equipment within a signalling and electrical control centre should be separated from other areas, such as offices, storage, unrelated processes and ancillary accommodation, by enclosing these in fire-resisting construction. The fire resistance appropriate for the enclosure should be based on the risk category (see **35.1**) and the fire load in the adjacent area.

35.5 Ventilation systems

Where heating and ventilation ductwork penetrates a fire compartment/separating wall, floor or ceiling, it should be provided with automatic fire/smoke dampers linked to the fire detection and fire alarm system, in accordance with BS EN 12101-8 and BS 9999:2017. The penetrations should be fire-stopped in accordance with BS 9999:2017.

Independent supply and extract systems should be provided to the control rooms and the associated means of escape, such that they do not become impassable due to fire and/or smoke from other ventilation systems.

Section 9: Reaction to fire (materials and finishes)

*COMMENTARY ON CLAUSE **9***

The fire risk offered by the materials used in the construction and fit-out of railway stations and tunnels can be significant. High population densities in the public areas of such premises are commonplace, and many of these occupants are likely to be unfamiliar with the premises. Most people are primarily concerned with starting or finishing their journey, and pay little attention to anything other than the features of the premises that help them fulfil these aims. It is therefore particularly important that the materials that are used to construct the premises, or those which are installed within stations and tunnels, are limited to those which have a minimal contribution to fire growth; this also significantly aids fire-fighting in the challenging sub-surface environment, by reducing the likelihood that fire-fighters will have to tackle large, uncontrolled fires. Material needs to be removed when made redundant to render the fire load risk as low as reasonably practical at all locations.

36 Surface locations

Materials in surface locations should meet the recommendations in BS 9999:2017, Clause **34**.

37 Sub-surface locations

37.1 Sprinkler-protected sub-surface stations

*COMMENTARY ON **37.1***

Sprinkler systems are not typically designed to extinguish fires, but they are demonstrably effective at limiting the spread of fire and controlling its growth, thereby reducing fire risk in many cases and being an effective aid to fire-fighting.

Public areas within a sub-surface station that are fitted with a sprinkler system conforming to BS EN 12845 should meet the same recommendations for reaction-to-fire performance of construction products as surface stations.

Where there are sprinkler-protected and non-sprinkler-protected areas, these should be fire-separated from each other using construction classified as EI 60 (E 60 for door sets) in accordance with BS EN 13501-2:2016.

NOTE Where sprinklers are installed in public locations (e.g. platforms) which are adjacent to the track, it is not necessary to fire-separate the sprinklered areas from the areas that accommodate the track and trains (e.g. the tunnels).

All materials used in the construction of internal walls and ceilings in the public areas of sprinkler-protected sub-surface stations should be classified as A2-s3, d2 or better in accordance with BS EN 13501-1:2018. Surface finishes applied to all walls and ceilings in the public areas of these stations should be classified as B-s3,d2 or better in accordance with BS EN 13501-1:2018.

37.2 Non-sprinkler-protected sub-surface stations and tunnels

Non-sprinkler-protected public areas of sub-surface stations, and all tunnels, should meet the recommendations given in Table 7.

Table 7 – Reaction to fire properties in non-sprinkler-protected sub-surface stations and tunnels

Profile	Parameter	Test method	Classification	Notes
Ceilings (downward facing) and vertical surfaces	Combustibility, smoke	BS EN 13501-1:2018	A2 (substrates) B-s1, d0 (linings, such as paint coatings) or better	
	Toxic fume	BS EN 45545-2:2013+A1, R7	CIT < 1.8	Identical to rolling stock exterior (HL2)
Flooring (upward facing) surfaces	Combustibility	BS EN 13501-1:2018	B_{fl}	
	Smoke	BS EN 45545-2:2013+A1, R10	Ds (max) < 300	Identical to rolling stock exterior (HL2)
	Toxic fume		CIT < 0.9	
Cables	Combustibility, smoke	BS EN 13501-6:2018	C_{ca}-S1a, d0,a3	
	Combustibility, smoke	BS EN 60332-3-24:2009	Charring < 2.5 m	d>12 mm
		BS EN 60332-3-25:2009		d<12 mm
		BS EN 61034-2:2005+A1	—A)	
	Toxic fume	BS EN 50305:2002	CIT < 10	Identical to rolling stock exterior (HL2)
Electrotechnical and other non-listed items	Combustibility	BS EN 45545-2:2013+A1, R23	LOI > 28% (UL94 V0 will also be accepted for the relevant thickness of material)	Identical to rolling stock exterior (HL2)
	Smoke		Ds(max) < 600	
	Toxic fume		CIT < 1.8	
Light diffusers, windows and other transparent or translucent items	Combustibility	BS EN 45545-2:2013+A1, R4	C_{FE} > 13	Identical to rolling stock exterior (HL2). This category only applies to limited extent surfaces (<0.2 m^2) defined in BS EN 45545-2
			Flame spread <150 mm within 60 s and no flaming droplets	
	Toxic fume		CIT < 0.9	

A) The smoke emission absorbance of bunched cable arrays in the EN61034-1 static smoke cube test should be related to the overall cable diameter *d* such that Ao(ON) < $0.7[\tan^{-1}(d/45) - \tan^{-1}(d)/2025]$ and Ao(OFF) < 1.8 × Ao(ON).

37.3 Other sub-surface locations

Non-public areas of sub-surface stations, and any rooms that have access or egress to or from sub-surface locations, should meet the recommendations applicable to basements in BS 9999:2017.

38 Enclosed locations

Enclosed locations should meet the recommendations given in Table 8.

NOTE Enclosed locations are not classified as sub-surface, but they share some of the same characteristics, and the same reaction-to-fire properties are applicable.

Table 8 – Reaction-to-fire properties in enclosed stations

Profile	Parameter	Test method	Classification
Ceilings (downward facing) and vertical surfaces	Combustibility, smoke	BS EN 13501-1:2018	A2 (substrates) B-s1, d0 (linings, such as paint coatings) or better
Flooring (upward facing) surfaces	Combustibility	BS EN 13501-1:2018	B_{fl}

Section 10: Fire safety during construction

COMMENTARY ON SECTION ***10***

This section covers both new construction sites and existing operational railway infrastructure undergoing redevelopment/construction works. This section applies to all railway infrastructure projects including stations, depots, control centres, tunnels and access shafts.

Additional recommendations and guidance are given in the FPA Joint Code of Practice [N2] and HSG 168 [N3].

Specific recommendations and safety requirements for tunnelling are given in BS 6164 and BS EN 16191 respectively.

39 Construction planning

39.1 General

NOTE Attention is drawn to the Construction (Design and Management) Regulations 2015 [10] in respect of the need to ensure that effective fire precautions are planned from the outset. HSE publication L153 [11] provides guidance for people with legal duties under the CDM Regulations.

Some railway infrastructure projects can take several years to complete and involve several construction phases. The phasing of the works and their fire safety aspects (e.g. means of escape), including temporary systems, should be addressed in the development of the construction phase plans to ensure that the fire safety measures will remain fit for purpose throughout the life of the construction project and that they have the ability to be extended or modified during that period if necessary.

For projects that involve existing railway infrastructure that will continue to operate during the works, ongoing liaison should take place with the infrastructure manager to ensure that the impact of the works on the operational areas are taken into account by all parties.

Works should not worsen any existing operational and fire safety provisions.

The location of construction sites near to operational railway infrastructure should be arranged such that existing fire safety provisions such as the means of escape, fire brigade access and access to hydrants are maintained. Any modifications should be reviewed and agreed with the railway infrastructure manager and the fire and rescue service, as appropriate.

The advice and best practice recommendations contained in the FPA Joint Code of Practice [N3] should be followed unless agreed otherwise with the enforcing authorities.

Fire precautions should include:

a) the use of materials classified as A1 in accordance with BS EN 13501-1:2018, wherever practicable;

b) materials and methods that avoid the need for hot work on site, particularly below ground;

c) design details that prevent the passage of smoke and flames up through a building during the construction phase;

d) design of access routes to enable contractors to construct buildings in a way that retains safe evacuation routes during the construction phase;

e) design for fire-fighting systems and fire alarm systems for their possible early use.

The construction period should accommodate, if necessary, the early installation of:

1) fire doors to protect escape routes;

2) fire compartments within the building (including fire doors and fire-stopping);

3) structural steelwork fire protection;

4) fire-fighting shafts and firefighters lifts (these should be commissioned and maintained);
5) automatic fire detection and fire alarm systems (where these are planned to be installed);
6) automatic sprinklers and other fixed fire-fighting equipment;
7) emergency lighting;
8) rising or falling mains for fire-fighting;
9) fire-fighting mains and fire hydrants.

39.2 Fire risk assessment

COMMENTARY ON ***39.2***

Understanding the risks associated with fire is essential to keeping construction sites safe from fire particularly, those involving sub-surface or high/deep structures. The Regulatory Reform (Fire Safety) Order 2005 [1] requires a suitable and sufficient fire risk assessment (FRA) to be carried out by a responsible person (the employer or person in control). Each principal contractor is responsible for the FRAs covering their work areas.

Construction sites below ground generally form a higher risk than normal due to limited availability of escape routes, unprotected escape routes and extended travel distances prior to the installation and completion of passive and active fire protection systems.

The fire risks on all construction sites should be proactively and continuously managed throughout the life of the project.

The advice and guidance contained in the FPA Joint Code of Practice [N2] and HSG 168 [N3] should be followed when carrying out FRAs. For tunnel construction sites, the recommendations in BS 6164 should be met.

The FRA should be based on the following five-step approach:

a) identify hazards: sources of ignition, fuel and oxygen;
b) identify people at risk: employees, contractors, visitors, travelling public and PRM;
c) evaluate and act: evaluate the hazards and people identified (above), and act to remove and reduce or control residual risk to ensure that people and premises are protected;
d) record, plan, inform, instruct and train: keep a record of the risks and action taken, prepare an emergency plan, inform and instruct relevant people, provide training, and co-operate with others;
e) review: keep the assessment under review and revise when necessary.

NOTE 1 Construction sites usually entail continuous change in layout, people, materials, processes and risks, therefore it is essential that the FRA be reviewed and updated regularly.

The FRA for a construction site should be reviewed at least every 6 months, or sooner, as the work and processes dictate.

Any works affecting the operational railway infrastructure should be coordinated with the railway infrastructure operator, to ensure that they have the necessary information to revise their FRA before any changes in the construction phasing.

NOTE 2 Additional measures might be necessary where modifying an existing railway infrastructure, where operational staff or the public might be present, or where phased completion is proposed. Each operational railway infrastructure has its own FRA.

39.3 Liaison with enforcing authorities and the emergency services

The advice from the authorities that enforce fire safety measures and that of the relevant fire and rescue services, as required, should be sought during the design and planning stages before construction starts.

For large and more complex railway infrastructure projects, regular liaison meetings should take place to inform the emergency services of any changes to the phasing of the works and the impact on the risk profiles, including the status of and access arrangements for temporary systems provided for fire-fighting.

Liaison meetings with the managers of the operational railway infrastructure and the emergency services should take place for any redevelopment works on existing operational railway infrastructure.

NOTE The range of issues to discuss varies according to the complexity of the project, but can include the items in the following non-exhaustive list:

- *signing into the site and other hazardous locations;*
- *roll calls;*
- *accounting for personnel going underground;*
- *the contractor's ability to deal with an incident and to ensure all personnel are accounted for and reach a designated assembly point – the contractor might have the most appropriate equipment to deal with the incident;*
- *emergency vehicle access, meeting point(s), and building, shaft or tunnel access points;*
- *provision of water supplies for fire-fighting;*
- *fixed installations, such as fire mains, hose connections and fire extinguishing systems;*
- *lighting, emergency communications (particularly below ground), ventilation and smoke control;*
- *means of escape, including the number, size and position of horizontal and vertical escape routes;*
- *fire-fighters' means of access, including transportation of equipment (e.g. lift, crane or train);*
- *the early provision of temporary fire-resisting construction to protect staircases and escape routes for construction workers and for the protection of emergency service personnel responding for fire and rescue purposes (e.g. descending below ground to establish a bridgehead);*
- *the operational capability of the emergency services and details of any additional facilities and equipment required for operations beyond that capacity (e.g. search and rescue limitations, including the use of extended duration breathing apparatus, and the underground transportation of casualties, personnel and equipment to the scene of an incident or bridgehead);*
- *the contractor's provision of an on-site emergency team (when and where applicable);*
- *provision of fire-fighting equipment and means for raising the alarm;*
- *familiarization visits for local emergency crews.*

39.4 Emergency planning

39.4.1 General

*NOTE 1 General recommendations for planning the response to a fire are given in BS 9999:2017, Clause **43**.*

NOTE 2 Principal contractors are responsible for preparing and testing their emergency plans on their construction sites.

Emergency planning should include procedures to ensure that:

a) everyone on site is aware of the emergency procedures;

b) any responsibilities assigned to individuals are carried out effectively;

c) appropriate training is delivered and is supplemented by regular refresher training;

d) people who do not have English as a first language are informed of the emergency procedures;

e) escape routes for the travelling public are appropriately segregated, sign-posted and illuminated;

f) access arrangements for maintenance and operation staff are clear;

g) managers of maintenance and operation staff understand the implications of the work, including the need for any additional training that is required to safely access the site.

NOTE 3 The operational railway infrastructure manager continues to be responsible for their emergency plans, and the revision of these in accordance with any impact of the works on their operational areas.

A desktop exercise should be carried out before work commences on site, to confirm that the emergency plan has been tested and that all persons responsible for managing emergencies are familiar with its content. All adjoining stakeholders who might be affected by an emergency on site should be invited to participate in the exercise, including the emergency services.

Training, including desktop exercises, should be repeated at least annually throughout the course of the construction work, and more frequently if there are significant changes to the site or work processes.

NOTE 4 Major infrastructure projects can take several years to complete, during which time the turnover of staff means that knowledge and experience moves on. Additional emergency planning training and refresher courses are usually necessary to ensure that all relevant personnel are kept appraised of the site emergency plans.

Both site emergency evacuation drills and injured person drills should be carried out at least once in each 6-month period (for both day and night shifts), and before major activities such as rail possessions, start of new major activities and any significant extension of the site to or working areas. All exercises should be observed and recorded for audit purposes. Any issues identified, and any changes made as a consequence, should also be recorded.

Drills and exercises should involve making an emergency call to the relevant emergency service(s), stating that an exercise is being undertaken and reporting the details of the incident being simulated. This should be coordinated in advance of the exercise.

NOTE 5 The simulated emergency call provides an opportunity for those managing a site or project control room to test staff and the accuracy of emergency numbers and procedures during the emergency call process. It is typically based on the METHANE model, which is illustrated in Annex D.

39.4.2 Site layout plans

Site access arrangements should be agreed with the fire and rescue service for each of the design phases.

Site access and egress via existing and operational railway infrastructure should be reviewed and agreed with the railway infrastructure operator.

Once work has started on site, an emergency grab pack should be provided at each location forming an emergency service access point, e.g. stations, shafts and portals.

The contents and detail for the grab packs should be agreed with the fire and rescue service during the planning stage to ensure that these are relevant and consistent, particularly for large projects with multiple access points and principal contractors.

The grab pack should be reviewed regularly and kept up to date to ensure that it reflects the layout and hazardous features on the site/structure.

Emergency grab packs should include as many of the following as are applicable:

a) site layout plans suitable for use by fire-fighters for fire-fighting purposes, detailing the rendezvous points, building/level floor plans showing the access points, fire-fighting shafts and lifts, temporary hoists and indicative fire-fighting bridgeheads, where agreed with the fire and rescue service;

b) positions of the nearest external fire hydrants;

c) position of the emergency exits from the sites including, where appropriate, via hoarding to adjacent third-party sites such as operational railway infrastructure or other construction areas managed by separate contractors;

d) dedicated emergency escape routes and staircases;

e) location of “green routes” through the construction sites allowing access by maintainers to already commissioned plant rooms without PPE;

f) position of high-risk rooms;

g) position of the control room;

h) position of fixed fire-fighting installations such as rising/falling mains and outlet locations, tunnel fire main and breeching inlet locations;

i) temporary and permanent ventilation systems and controls;

j) location of any areas covered by sprinklers or other fixed fire-fighting installations;

k) position of hazardous substances or areas such as flammable liquids, compressed gas cylinders, floor slab holes, high voltage electrical supplies and transformer rooms;

l) details of any specific hazards such as floor loading limits;

m) location of refuge chambers, rescue davits and any other specific equipment or facilities previously requested by the emergency services;

n) access keys, particularly if the site is unstaffed.

Grab pack plans provided for the emergency services should be simple A3 sized laminated line drawings showing the general layout configuration and orientation from the street level access point(s).

NOTE Detailed engineering plans showing extensive mark-ups are not usually appropriate for emergency use.

Where the public, operational and maintenance staff are present, the plans should be readily available and should clearly show safe routes to all the areas they need to access.

39.4.3 Premises information boxes

To assist the fire and rescue service in an emergency, particularly at night when a construction site might be unoccupied, the emergency grab pack should be kept in a premises information box installed in a prominent position close to the emergency service access point.

The contents of the premises information boxes at operational railway infrastructure should be maintained current to reflect the impact of the construction works on the existing emergency provisions.

39.5 Emergency services communications

*COMMENTARY ON **39.5***

An agreed radio system using a fire and rescue radio channel is required below ground and in structures that cannot support the usual line of sight radio communications. Without such systems, the fire and rescue service cannot communicate effectively below ground or operate a safe system of work during fire-fighting and rescue operations, which then puts the lives of the emergency responders at risk. The effectiveness of this radio system is a critical part of the construction infrastructure, often overlooked by those responsible for installing and maintaining such systems.

Issues affecting temporary fire and rescue service radio systems include:

- *the lack of consistency in radio systems installed between different principal contractors with varying states of effectiveness (radio systems appearing fully operational but unable to support fire and rescue service radios);*
- *interference caused by adjacent system antennas (tunnel systems affecting nearby station systems);*
- *temporary systems not designed to provide full coverage through the structure (such as between opposing fire-fighting shafts);*
- *loss of signal strength throughout the structure as the fit-out advances and introduces more steel and concrete into the building, including temporary signal losses caused by engineering/concrete trains located in tunnel sections);*
- *antenna cables and power supplies not marked or labelled effectively, including cables frequently cut and power supplies switched off by accident;*

- *radio tests carried out using signal strength meters which do not reflect real transmissions; voice-to-voice contact needs to form part of the system testing process;*
- *fire and rescue service radios set for higher gain and susceptible to greater levels of interference;*
- *fire hardening of cables.*

Designers and contractors should confirm the construction stage communications requirements with the emergency services as soon as reasonably practicable and at least before work construction work begins on site.

To ensure the effectiveness of the systems installed, the following recommendations should be met.

a) The systems should be tested regularly; the frequency should reflect the local site conditions and reliability.

b) The fire and rescue service should be invited to test their equipment on each temporary system once installed.

c) Provision should be made to enable the fire and rescue service to carry out regular checks on the system, e.g. during familiarization visits to the site.

d) Where practicable, a set of fire and rescue service radios should be used to carry out regular testing, to verify the reliability and compatibility of the system with fire and rescue service equipment.

40 Means of escape during construction

*COMMENTARY ON CLAUSE **40***

Operational railway infrastructures each have their own independent and segregated circulation areas and escape routes. These usually remain independent to the construction site, unless consultation and agreement has been obtained from the rail infrastructure manager.

For operational stations, the public are normally directed out of a station and left to make their own way to their destination, and so generally no assembly areas are provided for the members of the public.

Some construction sites are only accessible via operational railway infrastructure. Access and egress routes then need to be provided in consultation and approval from the operational railway infrastructure manager.

40.1 General

All construction site occupants should be able to escape quickly, easily and safely.

In order to provide safe means of escape on construction sites, at least the following recommendations should be met.

a) Routes: the fire risk assessment (FRA) should confirm the escape routes required.

b) Alternatives: well-separated alternative escape routes to construction site exits should be provided for site occupants where practicable.

c) Protection: where practicable, and when a need is identified by the FRA, routes should be protected by installing permanent or temporary fire separation and fire doors.

NOTE 1 This is particularly important for the protection of fire escape routes from below ground to surface level.

d) Places of relative safety: places of relative safety should be provided as determined by the FRA, such as in underground tunnel complexes or long tunnels.

e) Assembly points: escape routes should provide access to a place of ultimate safety away from the construction site where site occupants can assemble and be accounted for.

f) Signs: escape routes should be clearly identifiable and well signposted. Blind headings and dead ends should be marked as such. All signage should be reviewed regularly to verify that it continues to reflect the site layout.

g) Lighting: all escape routes; above and below ground, including tunnels, cross-passages and access shafts, should be provided with emergency lighting. Temporary emergency lighting systems installed during construction should meet the recommendations in BS 5266-1.

If a "green route" is provided to allow maintainers access to the plant without the requirement for PPE or site induction, it should be reviewed and agreed with the railway infrastructure operator.

NOTE 2 For some construction works, access routes to either existing or newly commissioned plant rooms might be affected. In these situations, "green routes" can be provided to allow maintainers access to the plant without the requirement for PPE or site induction.

NOTE 3 On large projects involving the construction and fit out of new tunnels with multiple access and egress points, it is reasonable to foresee that site occupants below ground may have to escape through designated fire escape routes they are not familiar with and which fall under the control of other principal contractors. It is essential that the client and principal contractors work together to ensure escape routes are maintained available at all times. All principal contractors should adopt a common system for accounting for personnel.

40.2 Fire warning systems

On all construction sites, arrangements should be made for raising the alarm and calling the emergency services in the event of a fire emergency anywhere on site.

The nature and operation of the emergency fire warning system should be related to the scale, layout and nature of the works, and extent of known fire hazards.

If the site is to be within or adjacent to operational railway infrastructure, the fire detection and fire alarm arrangements for the site and the railway should be coordinated.

NOTE 1 Fire warning systems on construction sites may comprise a range of solutions, from simple temporary hand-held devices to electronic systems featuring automatic fire detection. The choice is usually determined by the size of the site and its associated fire hazards.

The nature of the fire detection and fire alarm arrangements should be determined following the fire risk assessment (see **39.2**).

Operatives should be trained to recognize the differences between the different alarms within a construction site, such as fire and gas alarms.

Rooms that are determined as being high risk should be provided with automatic fire detection.

The use of air horns should be restricted to small work sites, and the devices should be protected from the elements and inspected weekly.

NOTE 2 Long-term use and exposure to sunlight has revealed limitations of relying on hand-held air horns. The devices tend to fail when operated, either through UV light, tampering or gas cartridge leakage, and therefore cannot be relied upon for large open plan sites, where a klaxon or handbell-type system would be more effective. For larger construction sites, such as tunnels, stations, shafts and maintenance buildings/yards, an interconnected wired or wireless temporary alarm system is likely to be more effective.

Where a fire detection and fire alarm system is installed within the construction site, it should meet the recommendations in BS 5839-1:2017.

Temporary fire alarm systems should be extended and modified as necessary during the construction work.

The alarm should be clearly audible to all site occupants.

NOTE 3 BS 6164 gives further guidance on alarm systems in tunnels.

All fire warning systems should be tested on a weekly basis.

Where construction works are being carried out on an operational railway infrastructure which is in use by members of the public, there should be a suitable interface between the site and the infrastructure alarm systems allowing them to communicate with each other.

The systems should be capable of sending and receiving grey signals to avoid unwanted fire signals and unnecessary evacuations.

NOTE 4 The principal contractor needs to discuss and obtain approval from the operational railway infrastructure manager to confirm that the temporary fire detection and fire alarm systems are appropriate, and, if necessary, that management procedures have been established by both parties.

Where the infrastructure is in operational use, the means of raising the alarm and the warning system should be consistent with the existing provisions such as automatic fire detection and public address/voice alarm systems.

NOTE 5 It is expected that the fire warning systems in site and operational areas do not lead to confusion or an inappropriate response. This is often more of an issue as the work nears completion and fire-resisting segregation is removed to complete the works.

41 Fire protection measures

41.1 Fire separation and compartmentation

Temporary fire separation and compartmentation within the construction site should conform to HSG 168 [N3].

NOTE 1 Unprotected staircases can act as a chimney for any fire breaking out below ground and fill with smoke, making them unusable as a means of escape by trapping people below.

To compensate for heavy foot traffic during construction works, mechanical hold-open devices that release the doors on operation of the fire signal should be used. Such devices should meet the recommendations in BS 7273-4.

Temporary fire separation between construction sites below ground, e.g. station and tunnel construction sites, should normally have fire resistance not less than EI 60 min (and R 60, for load-bearing construction) in accordance with BS EN 13501-2:2016.

NOTE 2 This is expected to provide sufficient time for people to escape from below ground, and to prevent the conditions deteriorating beyond the point where the fire and rescue service are unable to fight the fire.

The materials and methods used to construct the fire separation should be chosen to meet the stability, integrity and insulation criteria.

NOTE 3 Doors and partitions created from flame-retardant-treated materials, hung on gate hinges which do not self-close and have large openings above, below and around the doors, are not fire-resisting and do not constitute good practice.

For temporary works involving fire compartmentation and separation of high-risk rooms, cross-passages, public areas, or other work sites, the materials and method of construction should have not less than 60 min fire resistance.

Fire compartmentation should be maintained during construction. Openings made for the passage of cables and building services should be temporarily fire-stopped to prevent the spread of fire flame, heat and smoke from the room, space or tunnel of origin.

Where construction works are within or adjacent to operating railway infrastructure, and the boundaries are located within an enclosed environment (e.g. within a station building), then those boundaries should incorporate a barrier that provides 60 min fire-resisting separation between the construction site and the railway.

Where the boundary is not within an enclosed environment, but is adjacent to an escape route or other public circulation space, then it should also be separated from the escape route or circulation space by a screen, which should have 60 min fire resistance and a height not less than 2.2 m above floor level.

The works and hoarding provisions should be reviewed and agreed with the operational railway infrastructure operators and regulators.

Where fire-resisting hoardings include doors for site access and egress, these doors should have the same fire rating as the fire-rated hoarding. Any escape doors should readily openable from within the site without the use of a key.

NOTE 4 Doors generally open inwards into the construction site, unless more than 60 occupants are to use the door for escape purposes.

If it is necessary to remove the hoarding during the later stages of a project, to allow services and finishes to be completed, these works should be reviewed and agreed with the operational railway infrastructure operators and regulators. The hoarding should not be removed until all the fire protection works associated with the work site are complete and operational.

Temporary fire-stopping arrangements for building and tunnel services that pass through fire-resisting structures, including hoardings, should be taken into account during the design and implemented during construction.

All fire doors separating compartments or protecting staircases should be checked every week to verify the doors have not been damaged and remain self-closing. The results of the check should be recorded in a fire safety log-book.

41.2 Temporary protective floor and wall coverings

Where temporary protective coverings are to be used within construction sites, they should meet the following classifications:

a) floors: classified B_{fl} in accordance with BS EN 13501-1:2018;

b) installations other than floors: flexible or rigid sheeting, in accordance with LPS 1207 [N5] or LPS 1215 [N6] according to the application. LPS 1215 materials should be used only in external locations;

c) other types of materials: classified B-s_1, d_0 in accordance with BS EN 13501-1:2018.

Where the temporary coverings are to be applied to works exposed to operating railway infrastructure, they should meet the same standards as would be applied to permanent installations.

The fire performance of floor coverings should not rely upon surface coatings or treatments, as these are not typically tolerant of the wear associated with foot traffic.

In all cases, wall and floor coverings should be permanently marked with their fire performance, and this marking should be visible when installed.

Where flexible protective covering has been overprinted (e.g. with advertising), this should not adversely affect the fire performance of the material.

41.3 External hoarding

Where external hoarding is required to be fire-resistant, this should be included in the design brief.

41.4 Construction materials delivered to the site

The delivery and storage of materials delivered to the construction site should be coordinated. Appropriate measures should be taken to limit the potential fire load and fire spread between materials, particularly when taken below ground.

The use of combustible packaging and materials should be kept to a minimum. Redundant packaging and other combustible products should be removed from the site as soon as is practicable.

41.5 Routine testing and maintenance of fire protection equipment

All equipment should be maintained in good working order, and this should be verified by routine testing in accordance with the manufacturer's instructions.

All portable fire-fighting equipment should be inspected and maintained in accordance with BS 5306-3.

41.6 Temporary tunnel ventilation systems

Temporary tunnel ventilation systems should meet the recommendations given in BS 6164.

The emergency control of the ventilation system should be taken into account during the design and planning stages and appropriate training should be provided to all relevant staff.

NOTE Emergency remote operation of the ventilation system might be required from a control room which could be several miles from the tunnel.

A continuous supply should be secured and maintained whilst the ventilation is in use. This should be planned during the design stage with all affected stakeholders.

Generators and power supplies should not be located in adjoining work sites, or where works are planned which might affect the availability of the supplies.

41.7 Fire safety signage

Fire safety signs should be provided to indicate:

- fire and rescue service access routes;
- fire action notices;
- escape routes, fire exits and dead ends;
- positions of tunnel fire main breeching inlets, fire main inlets and fire main outlets;
- fire extinguishers;
- fire alarm call points.

A process should be in place to check and review the signage regularly, to verify that it is in place and has not been removed following the installation of additional equipment, and that it remains fit for purpose. Signs installed to indicate temporary escape routes should be checked at least weekly to verify that the signs have not been inadvertently moved without notification.

Standard fire hydrant signage should not be used to indicate fire main outlets and landing valves below ground (see BS 9990:2015).

Wayfinding exit signage in accordance with BS 5499-4 should be provided in railway infrastructure under construction to indicate the nearest exit route to a place of safety.

All temporary fire safety signage provided during the construction stage should conform to BS ISO EN 3864-1 and BS EN ISO 7010.

NOTE BS 5499-4 and BS 5499-10 give information for the application, size, siting and durability of signage.

All emergency signage should be illuminated by both normal and temporary emergency lighting systems.

42 Facilities for fire-fighting during construction

*NOTE General recommendations for access and facilities for fire-fighting are given in Section **5**.*

42.1 Water supplies for fire-fighting

42.1.1 General

Water supplies for fire-fighting should be provided in accordance with Clause **20**.

Where new fire hydrants are required these should be installed as early as possible. All fire hydrants should be clearly marked in accordance with BS 3251.

All fire hydrants should be kept clear of obstructions in order to allow unrestricted access for the fire and rescue service.

Suitable access and marking provision should be made for fire hydrants obscured by site hoardings.

Water tanks required for fire-fighting should be installed early to supply any temporary fire-fighting mains planned for the works.

42.1.2 Fire-fighting mains

Where temporary fire-fighting mains are to be installed during construction, they should be designed, installed, maintained and tested in accordance with BS 9990:2015. Test records should be maintained for inspection purposes.

Temporary systems should not be fitted in the same place as permanent systems. Wherever practicable, the permanent systems should be installed early in construction so that temporary systems can be avoided.

NOTE Fire mains, including temporary systems, require careful planning. Relocating the main during construction and fit-out can cause significant delays and disruption.

42.1.3 Tunnel temporary fire main

A fire-fighting main should be provided during tunnel boring operations and during the fit-out stages of tunnel construction.

If a permanent fire main in accordance with BS 9990:2015 cannot be installed during the initial construction phase (or is not required due to the final use of the tunnel, such as a sewer pipe), the design specifications should be discussed and agreed with the fire and rescue service at the planning stage to confirm the minimum operating requirements.

Where a tunnel-boring machine temporary cooling main also forms the temporary fire main, the system should have sufficient capacity to supply water for any TBM sprinkler system and radial smoke curtains, together with at least two effective fire-fighting jets.

For TBM drives in remote locations, temporary fire main breeching inlet locations should be agreed with the fire and rescue service at the planning stage and before being installed.

Temporary tunnel fire main systems should also meet the following recommendations.

a) Breeching inlets should conform to BS 5041-3. The breeching point and associated pipework should be supported to prevent movement and damage during construction and positioned not less than 1 m from the floor.

b) External breeching inlets should be clearly marked and illuminated, as they might be required during the hours of darkness.

c) All temporary fire main breeching inlets should be maintained readily accessible at all times.

d) Instantaneous hose connections conforming to BS 336 should be fitted to all temporary fire main breeching inlets and landing valve outlets.

   NOTE The fire and rescue service are not equipped with any other types of hose couplings.

e) Double outlets (with individual delivery valve control) should be provided at 50 m intervals in the tunnel.

f) Flexible connections on temporary fire mains should not be used due to their reduced diameter and effect on the flow rate.

g) The temporary fire main should be pressure- and flow-tested at least annually, or following a change to the system.

The fire and rescue service should be invited to attend whenever the testing is taking place.

42.2 Portable fire-fighting equipment

Portable fire extinguishers should be provided on all railway infrastructure construction sites. The extinguishers should be selected and installed in accordance with BS 5306-8 and maintained in accordance with BS 5306-3.

The type of extinguishers used in tunnels, and the spacing between fire points during the tunnel fit-out stage, should be determined by fire risk assessment. Dry powder extinguishers can lead to asphyxiation and visibility hazards, and therefore should not be used indoors unless their use is explicitly supported by the risk assessment.

The suitability and adequacy of the fire points and fire extinguishers provided should continue to be reviewed as construction progresses and the site changes.

All fire extinguisher points should be clearly visible and be maintained free from obstructions at all times. Each fire point should be clearly illuminated by both the normal and emergency lighting.

For tunnelling operations, all persons working below ground should receive practical training in how to use an extinguisher.

42.3 Plant and vehicle fire suppression

All plant and vehicles with internal combustion engines used below ground during tunnel construction (including diesel locomotives used during fit out stages) should be fitted with an automatic fire suppression system, and should conform to BS 6164 and BS EN 16191.

All plant and machinery used below ground should use fire-resistant, water-free hydraulic fluids conforming to ISO 12922 or low flammability fluids.

NOTE BS 5306-0 gives guidance on the selection of appropriate systems.

43 Use of acetylene below ground

*COMMENTARY ON CLAUSE **43***

Whilst general safety advice on the use of acetylene is provided in the FPA Joint Code of Practice [N2], it is not normally recommended for use below ground due to the inherent fire and explosion hazards presented by the cylinders. Nonetheless, it is recognized that there are occasions when there are no other alternatives for the work process.

Previous projects have required the use of oxyacetylene to cut up the TBM when tunnelling has been completed. In this instance, the cylinders were stored above ground and additional pipework/hoses were used to reach the TBM below ground.

Oxyacetylene is also used for point welding once the tracks are laid, and this could be several miles into a tunnel section. In this instance, additional measures are required to ensure the risks are reduced to as low as reasonably practicable.

Examples of risk control measures include:

- *permit to work system;*
- *reduced size cylinders taken into the tunnels (sufficient for the duration of the shift);*
- *cylinders transported in by train on custom-built carrying frames with fixed fire suppression installed.*
- *valve keys available;*
- *fire watch system with fire-fighting equipment;*
- *cylinders removed from the tunnels at the end of each shift, e.g. facilitated by dog tags;*
- *enhanced risk assessment and method statements and emergency plan put in place (including METHANE message for the fire and rescue service; see Annex D);*
- *regular notification to the fire and rescue service of the use and location of acetylene when below ground;*
- *updating the fire and rescue service grab packs with relevant information.*

The advice of the fire and rescue service should be sought before any work commences.

The fire and rescue service should continue to be kept updated on the use and location of acetylene below ground.

Section 11: Fire safety systems design

44 General recommendations for fire safety systems design

The configuration and technical requirements for the design of any part of railway infrastructure should be defined in a fire safety strategy document.

The fire strategy should define the standards to be used for the design of all key fire protection systems that are to be incorporated in the works, and the categories or fire performance ratings required of those systems.

45 Passive fire protection

*COMMENTARY ON CLAUSE **45***

Passive fire protection systems support the performance of fire-resisting elements of construction, including walls, floors, ceilings, doors and shutters. This clause also addresses fire-stopping, ductwork, dampers and cavity barriers.

T*he recommendations in BS 9999:2017 provide minimum levels of passive fire protection. They do not specifically address business continuity or asset protection, which can be key for some railway industry stakeholders.*

45.1 General

The design of buildings for railway infrastructure should meet the recommendations in BS 9999:2017, Section **7**.

45.2 Fire resistance

45.2.1 Structural protection

The fire resistance for elements of structure, including floors, should be not less than the following classifications, as defined in BS EN 13501-2:2016:

a) R 60 for surface stations;

b) R 90 for enclosed stations;

c) R 120 for subsurface stations and shafts serving tunnels.

NOTE These minimum values apply regardless of whether sprinklers are installed.

45.2.2 Roof structures

Fire resistance of roof structures should be in accordance with BS 9999:2017, **30.2.4**.

45.2.3 Compartmentation and fire separation

*COMMENTARY ON **45.2.3***

The sub-division of railway infrastructure and its accommodation using compartmentation and fire separation is an important fire protection strategy for an operational railway.

Fire compartmentation and fire separation should be in accordance with BS 9999:2017, with the following exceptions (all ratings are as described in BS EN 13501-2:2016).

a) Where practicable, public and non-public areas should be fire separated using construction classified EI 60 or more. Where this is not practicable (e.g. in rooms that accommodate ticket vending windows), then the room(s) containing those facilities should be fire separated from the rest of the non-public areas by construction of the same classification.

b) The structural fire resistance should be in accordance with **45.2.1** above, rather than BS 9999:2017, Table 23 or Table 24.

c) Rooms containing plant, machinery and equipment should be separated from the rest of the premises by fire-resisting construction classified EI 60 or more.

d) Retail facilities in the public areas of stations should be enclosed within a minimum of EI 60 fire-resisting construction.

e) Storage areas for refuse within buildings should be enclosed within a minimum of EI 60 fire-resisting construction, regardless of room size.

45.3 Openings

45.3.1 General

Openings should meet the recommendations given in BS 9999:2017, Clause **32**, with the following exceptions and additions.

45.3.2 Fire-resisting doorsets and shutters

Fire-resisting doorsets should have at least the same fire resistance as the wall in which they are installed.

NOTE In all cases, fire-resisting doorsets may be classified "E" only under BS EN 13501-2:2016, i.e. they do not require any specific insulation performance when fire-tested.

Fire-resisting doorset assemblies should conform to BS EN 16034.

45.3.3 Fire-stopping and service penetration seals

Fire-stopping and penetration sealing systems should be in accordance with BS 9999:2017, **32.6**, and the fire resistance performance of those systems should be the same as the element to which they connect or seal.

In locations where train movements could cause movement between structures, the fire-stopping should be designed to be able to accommodate such movement without compromising its fire performance.

The design of the fire-stopping and any associated service routes passing through fire-resisting elements should be completed and coordinated with other services and structures before construction commences.

Apertures provided for service penetrations through fire-resisting elements should accommodate not only the openings for the services but also the space required for the installation of passive fire protection systems to seal those apertures.

There should be provision for suitable and sufficient methods of replacing or adding services without damaging their associated passive fire protection. Where it is foreseeable that reconfiguration of services will be a regular occurrence, then fire-resisting systems designed to accommodate those alterations should be installed, and sufficient space for access to those seals should be maintained both during and after construction.

45.3.4 Evidence of fire performance

All documentation, such as fire test reports, classification reports and declarations of performance related to the fire protection systems to be installed, should be submitted to the duty holder. These documents should provide the necessary assurance that the products used are in accordance with the relevant standards and fit for purpose.

Combinations of elements that are intended to be used as a whole system should be tested or assessed as such.

On completion of any fire protection installations, the products/materials used in those works should be recorded by means of a register containing a clear description of where the fire protection products have been installed and photographs showing the completed works. This should be copied to the duty holder and/or building user.

46 Fire detection and fire alarm

46.1 General

All railway stations should, as a minimum, have a public address (PA) system capable of giving warning in case of fire to all habitable parts of the premises.

Where stations equipped only with a PA system might remain open to the public whilst no staff are on the station, there should be a means by which a warning of fire can be given to the occupants via the PA from a remote location. That remote facility should be staffed at all times when the premises are open to the public. There should be a means by which the occupants of the station (both staff and members of the public) can swiftly and effectively communicate with the staff at that location to notify them of the location and nature of fire emergency.

If railway premises include buildings, then the need for a fire detection and fire alarm system should be determined according to the recommendations in BS 9999:2017, based upon the risk profile assigned to any non-public areas.

NOTE 1 In this context, "buildings" would not include small, single-room structures such as detached waiting rooms, equipment rooms or signal cabins.

The category of system installed in stations should be L5/M as defined in BS 5839-1:2017, with the coverage of any automatic detection being defined by a risk assessment undertaken by the fire system designers, and incorporating any specific requirements communicated by the duty holder.

In railway premises other than stations, the category of system should be determined by the BS 9999:2017 risk profile.

Automatic smoke detection should not normally be installed in public areas of stations, unless required to activate other fire protection systems (e.g. smoke control systems or to close doors normally held open).

Sub-surface stations should have a manual fire alarm call points installed in both public and non-public areas, unless otherwise agreed with the duty holder. If manual call points are omitted, there should be some other means provided within the station that allows passengers to contact the railway or station operator easily to report a fire.

NOTE 2 An emergency voice communication system in accordance with BS 5839-9 would be appropriate. If the duty holder has other passenger help point installations that are continuously monitored, these would also be acceptable.

Fire detection and fire alarm systems in stations that are left unstaffed whilst occupied by passengers should be remotely monitored for condition and status, at a permanently staffed location from where emergency responses and/or reactive maintenance can be initiated. Where these arrangements are provided via a third-party alarm receiving centre, they should be in accordance with BS 8591.

Sub-surface stations and other stations that have public areas which operate under a staged, phased or progressive evacuation strategy (as defined in BS 9999:2017) should use a public address/voice alarm system as the means of giving warning of fire to members of the public.

Public address/voice alarm systems should conform to BS 5839-8. Where non-automatic public address alone is used to instruct members of the public in a fire emergency, then the system should follow the principles in BS 5839-8 as far as is practicable.

Fire detection and fire alarm systems should not normally be installed in railway tunnels. In accommodation attached to tunnels, the recommendations above should be met.

46.2 Equipment selection

The control protocol for fire alarm detection and control equipment, should be agreed with the duty holder. If detection systems are to be integrated, the control protocol should be determined accordingly.

Where the duty holder requires specific equipment to be used, this should be specified by them before the design of the systems commences.

Where possible, the main fire alarm panel should be located in a designated location, such as the station's control room or control point. Where no such designated location exists, the fire panel should be located where a fire emergency can be controlled in reasonable safety, and where it will be accessible to the fire-fighters attending any incident. The location should be agreed with the duty holder, in consultation with the relevant fire and rescue authority.

Where repeater panels are installed, the functionality of these (i.e. whether they are to be fully or partially functional, or operate purely as status indicators) and their locations should be agreed with the duty holder.

Interfaces for the fire detection system should allow both automatic and manual control of equipment installed for fire-fighters' use, including ventilation for smoke management and smoke clearance, as required by the fire strategy and in accordance with Section **5**.

"Emergency Do Not Enter" (EDNE) signs should be provided at the following locations to deter people from entering a station in an emergency situation:

a) at all publicly-accessible entrances and exits of sub-surface and enclosed stations;

b) at locations where there is direct internal access for members of the public between the railway premises and those used for other purposes (e.g. shopping complexes);

c) where there is an interface between two separate railway stations.

The signs should be automatically activated by the fire detection and fire alarm system, and should warn of the emergency automatically using lights, sound, text and pictogram messages, the form of which should be agreed with the duty holder.

Where there is no fire detection and fire alarm system in the premises, but EDNE signs are installed, then the means of operating them should be determined by the duty holder.

Where an additional functionality exists to use signage for non-emergency crowd control (normally "Do Not Enter" or DNE), the form of warning should be such that it cannot foreseeably be confused with the emergency function.

46.3 Cause and effects

At staffed stations, an alert stage (acknowledgement and investigation) period should be provided to allow the operator sufficient time to investigate an activation so that an unwanted alarm does not cause an unnecessary evacuation. This should be configured as a staff alarm in accordance with BS 5839-1:2017.

The acknowledgement and investigation times should be agreed with the duty holder and the fire and rescue service.

At unstaffed stations and other railway buildings, there should be no delay in the sounding of the fire alarm.

Stations should operate simultaneous evacuation unless agreed with (or specified otherwise by) the duty holder. Stations operating under other evacuation arrangements should meet the relevant recommendations in BS 9999:2017.

NOTE 1 Where a station is integrated with another station or premises, and these premises are capable of operating completely independently of each other in a fire emergency, then they may be configured such that one remains occupied whilst the other evacuates. This would be dependent on agreement with the duty holder and consultation with the fire and rescue authority.

When the fire system initiates an evacuation event, all ticket gates should immediately and automatically open to their full extent, and any doors or gates held open or shut should release, in accordance with BS 7273-4.

In the event of a fire incident, a means of providing communication with adjacent premises, where those are integrated with stations or are over-station developments, should be agreed with the duty holder(s) in those premises.

Upon evacuation of a staffed station, the cause and effects for the fire detection and fire alarm system should activate the following, as required.

a) Ventilation should operate in accordance with the smoke management strategy for the site, including (but not limited to) activation of appropriate dampers and stair pressurization.

b) Any EDNE signs preventing access to that premises should activate.

NOTE 2 Some complex locations might require the activation of EDNE signs during the alert stage depending on the site-specific fire strategy.

Fire detection and fire alarm systems in buildings other than stations should operate in accordance with BS 9999:2017 and BS 5839-1:2017.

46.4 Notification of fire in other railway premises

Within rooms accessed only via tunnels, if a fire is detected by automatic detection, an alert should be sent automatically to the route or line control centre in accordance with the site-specific fire strategy and the duty holder’s requirements.

46.5 Subsequent operations

The duty holder should confirm to the designers how they intend to operate the train service in the event of a fire emergency (this should be part of the operational concept for the railway). This should include a clear description of the circumstances in which the train service will be halted and those in which the train service will continue to run, including services not stopping at the incident location.

Where these circumstances are expected to differ according to the location of the incident (e.g. in stations, in tunnels or locations accessed via tunnels and in open sections), this should be clearly defined by the duty holder.

The design should enable the fire safety aspects of the operational concept to be conducted in reasonable safety. If the designer is concerned that this might not be practicable, they should consult with the duty holder to establish whether the operational concept or the design should be altered.

46.6 Fault reporting

The status of fire life safety systems, including but not limited to the fire-fighting shaft pressurization and suppression systems, should be indicated on the main fire alarm panel.

47 Fire suppression and extinguishing systems

47.1 Life safety

The need for fire suppression and extinguishing systems for life safety reasons should be established in accordance with Section **9** and BS 9999:2017.

For sub-surface stations, where habitable machinery spaces containing machinery or electrical switchgear cannot practicably be fire-separated from the public areas of the station, and they are located on escape routes, they should be protected by sprinkler or watermist fire suppression systems conforming to BS EN 12845 or BS 8489-1 respectively.

47.2 Business continuity

COMMENTARY ON ***47.2***

The failure of critical systems on the railway environment could impact a large section of infrastructure, or possibly cause an unsafe situation to arise. Major damage to a station from fire could render part or all of it unavailable for an extended period. The recommendations in this subclause are intended to aid the designer in assessing the criticality and redundancy of systems in the railway environment. Figure 4 illustrates the decision-making process in the form of a flowchart.

For all stations, if the duty holder considers that fire suppression or extinguishing systems might be required for asset protection or business continuity reasons, they should instruct the designers to assess that need in accordance with the recommendations for property protection and business continuity in BS 9999:2017, and for electronic equipment in accordance with the guidance in BS 6266. It should not be assumed that the provision of fire suppression/extinguishing systems alone provides the necessary level of fire protection for asset protection and business continuity.

Access arrangements for emergency services should also be taken into account. Where access to rooms containing equipment essential for business continuity is likely to be delayed, resulting in serious damage to the equipment before intervention of the emergency services, suppression should be provided.

For electronic equipment, information should be gathered for the risk assessment process established in BS 6266. This should be undertaken as follows.

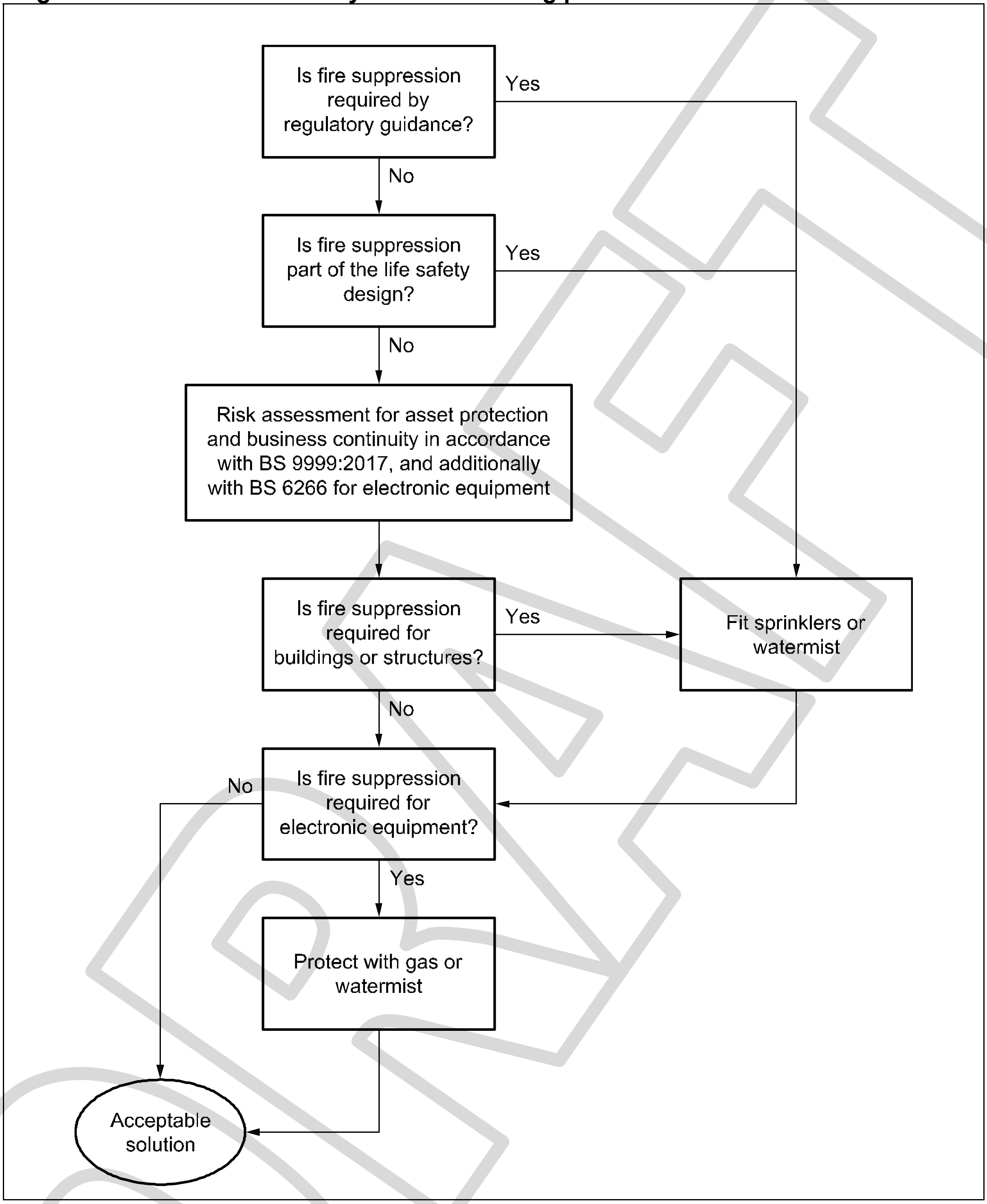
a) Initially the criticality of the rooms and/or systems should be assessed. If the area under consideration is a safety critical element, then it should be determined whether services have redundancy built in.

   NOTE This could be by means of provision of additional, secondary, equipment. Redundancy can also be provided if the services are split, for example if an electrical element is fed by diverse routes.

b) The level of maintenance expected to be provided to both the suppression system itself and to the equipment should be taken into account.

c) Consultation should be undertaken with the rail operators and other stakeholders for assessing the acceptability of suppression systems.

Figure 3 – Business continuity decision-making process



48 Emergency lighting

Emergency lighting should be provided in all internal locations in railway premises.

Where normal lighting is installed in open areas, then emergency lighting should also be installed.

Normal and emergency lighting should be provided on all open areas that could serve as escape routes from the premises, up until those routes reach a place of ultimate safety.

Emergency lighting should be in accordance with BS 5266-1 as a minimum in all premises, and additionally with RIS-7702 [N4] in stations.

NOTE BS 5266-1 distinguishes between lighting for general use following the failure of normal lighting, which is usually referred to as emergency lighting, and emergency escape lighting, which is provided to assist building occupants to escape during a fire.

The maintained horizontal illuminance of emergency lighting on an escape route should be not less than 2 lux measured at the walkway surface, with a diversity not exceeding 40:1.

Emergency lighting in public and normally occupied non-public areas at sub-stations should provide illuminance of 10 lux average, 5 lux minimum on designated escape routes.

49 Station smoke control

There should be consultation with the duty holder and enforcing authorities to determine the necessity and the criteria for smoke control ventilation within enclosed and sub-surface stations. Ventilation should be provided where necessary to maintain a tenable environment during a fire emergency to allow occupants to reach a place of ultimate safety.

The ventilation system should account for a train on fire at the station and for a potential fire elsewhere in the station (these should be treated as separate events).

A tenable environment should be provided for the duration required:

a) for all occupants, including PRM, to evacuate;

b) for people who cannot self-evacuate to be aided;

c) for the fire and rescue services to arrive and begin to attend the incident.

The following conditions should be met in order for an environment to be deemed tenable.

1) Measures should be put in place to prevent the smoke layer from descending below 2.5 m above the floor level.

2) The smoke temperature should not exceed 60 °C along the evacuation route at a height of 2.5 m above the floor level.

3) The smoke layer temperature should not exceed 200 °C above the evacuation route and the maximum radiant heat flux should not exceed 1.7 kW/m^2.

4) The visibility distance for light reflective signs should be not less than 10 m.

   NOTE 1 Toxicity is deemed acceptable if visibility is not less than 10 m along the evacuation route.

5) Air velocities along escape routes should not exceed 11 m/s;

6) The ventilation system should be capable of performing under the meteorological effects (i.e. wind forces and barometric pressure differences) that are likely to be prevailing for 99% of any year.

The design of any ventilation system should account for a situation where a train might have been on fire for some time when travelling to the station.

Ventilation systems and equipment should:

- meet the applicable parts of the BS EN 12101 series of standards;
- be provided with a power supply in accordance with BS 8519;
- include redundancy to enable operation of the ventilation system to continue reliably during a fire emergency and to account for planned and reactive maintenance;

  NOTE 2 For mechanical ventilation systems, a standby fan and associated equipment within each ventilation shaft or fan room would normally be sufficient to provide adequate redundancy. For natural ventilation systems, spare vents/outlets might be required.

- be provided with sound attenuation to prevent noise levels in the station from exceeding 85 dB(A).

NOTE 3 Where installations are close to residential premises, environmental health enforcers might prevent fan testing at full power, particularly at night, to protect residents from excess noise. Guidance on sound attenuation is given in BS 4142.

50 Fire-fighting water supplies

Water supplies for fire-fighters within station buildings should be provided in accordance with BS 9999:2017 and the systems should conform to BS 9990:2015, with the following exceptions and additions.

a) Open platforms on surface stations should not be included when calculating hose distances for the purposes of determining the need for fire main outlets. Only the footprint of the station building itself need be included.

b) Where fire mains are installed such that the low points of pipework do not coincide with landing valves, drainage valves should be included so that no part of the system requires joints to be broken for drainage purposes. These valves should be accompanied by facilities accommodating the disposal of any drained water.

NOTE Whether this requires drains, sumps or pumps depends upon the maximum quantity and flow rate of water that the facility is expected to accommodate.

c) The type of fire main should be consistent throughout the premises, and where multiple mains are installed they should wherever practicable be interlinked so that any external inlet associated with the premises can supply all outlets. Where this is not practicable, the signage on the inlets should be designed in consultation with the fire and rescue service to clearly and unambiguously indicate which parts of the premises it serves.

51 Emergency signage and fire safety notices

*COMMENTARY ON CLAUSE **51***

At stations, the movement and directing of passengers is a key process for an efficient operation. Various signage is provided for orientation ranging from ticket purchase, waiting rooms and retail to the platforms and the way out of the station. The provision and design of emergency signage and fire safety notices toned to reflect the operational requirements of the railway.

Emergency signage should be provided in accordance with BS 5499-4.

NOTE Where "way out" signage is provided as part of the normal wayfinding, and this directs passengers towards the most appropriate station exits, additional emergency exit signage is not required.

If green background emergency exit signage is to be provided along the platforms, measures should be taken to avoid any potential confusion with train signals along the train driver's signal sighting.

Fire safety notices should be provided in accordance with BS 5499-10.

Where an existing station is redeveloped, the stakeholders should be consulted with regard to the continuation and integration of the new scheme within the existing station signage systems.

Annex A (informative)
Worked examples for calculating egress times

A.1 General

For the purposes of example calculations, the station occupant loads have been established in accordance with Section **4**. It is the purpose of this annex to demonstrate how calculations can be used to establish platform and station clearance times.

Egress calculations for stations are most usefully formatted with the formulae and calculations presented so that they can be easily reviewed. Spreadsheet calculations ought not to use formulae which are not visible on a printed copy.

The calculations need to contain an explanation/description for each stage as well as any formulae used. They need to be linked to a plan drawing or sketch, which in turn needs to be marked with egress locations, detail of each egress element (i.e. doorway, corridor, stair escalator, including clear widths) and travel distances.

It is inappropriate to use the BS 9999:2017 floor space factor approach when determining occupant load.

The sources of occupant data need to be clearly identified and agreed with stakeholders; they will normally include:

- both peak am and pm passenger data for all platforms, alighting and boarding;
- the headway (interval between train services) for each platform during peak periods.

The peak am and pm figures need to be stated for each peak 60 min period. If alternative methods are to be used to establish peak figures, then the methodology and input data will need to be agreed with stakeholders.

The peak period load during the busiest hour for both am and pm needs to be established with regard to the maximum number of persons who could be waiting for a train ("boarders") and those passengers that are expected to leave the train ("alighters").

NOTE This peak demand needs to be calculated. It is not commonly the 1 h peak equally divided by the headway value.

The total evacuation time is the sum of the walking (movement) time for the longest exit route plus the waiting/queuing times at the various circulation elements.

A.2 Evacuation calculation examples

A.2.1 Symbols

For the purposes of this annex, the following base symbols and definitions apply.

C	concourse clearance time, in minutes
E	egress capacity, in persons/minute
F	egress flow time, in minutes
M	movement time to a place of ultimate safety, in minutes
O	occupant load, as number of persons
P	platform clearance time, in minutes
T	travel time, in minutes
W	waiting time, in minutes

Within each example, suffixes are added to indicate individual elements, as follows.

b	barrier
c	concourse
fg	fare gate
g	gate
i	inbound
o	outbound
p	platform
pi	inbound platform
po	outbound platform

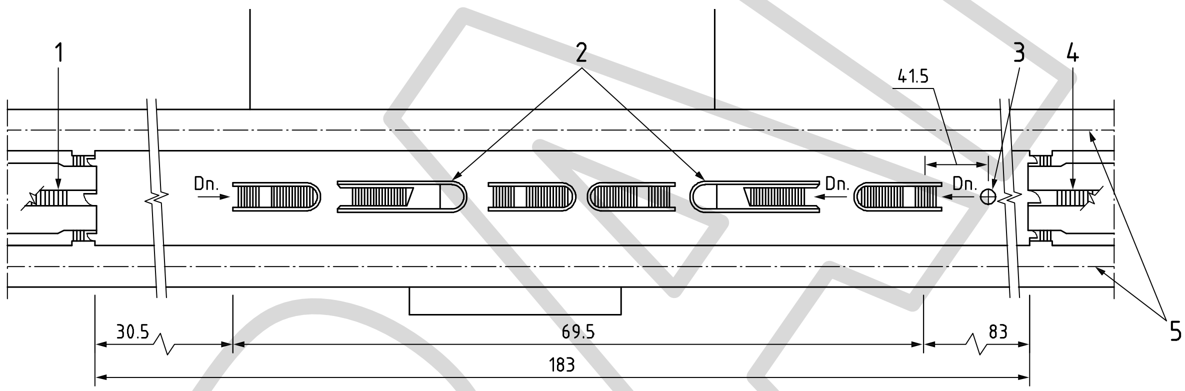
A.2.2 Island platforms

A.2.2.1 Basis of example

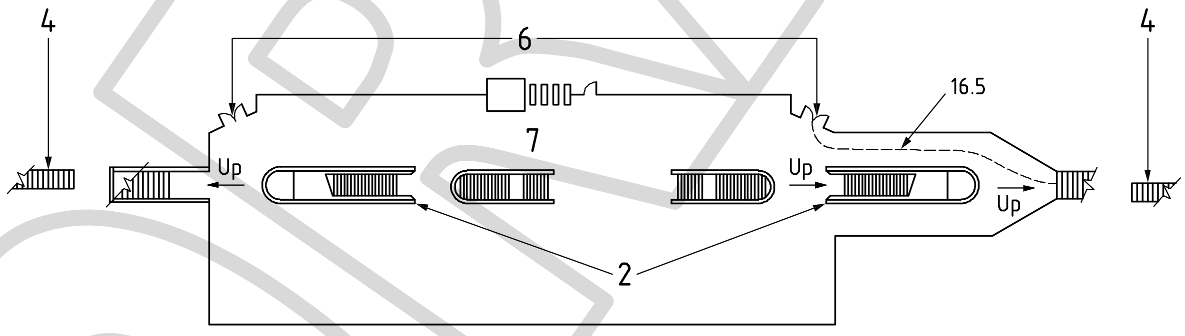
An example of an island platform station is shown in Figure A.1.

Figure A.1 – Island platform station

Dimensions in metres



a) Platform level



b) Concourse level

Key

1	Emergency stairs to grade level
2	Escalators
3	Point on platform furthest from an exit point
4	Emergency stairs
5	Track
6	Emergency exits
7	Paid area

The following example is for an island platform in a surface station with the platform above a grade-level concourse. Table A.1 and Table A.2 give the data for this example.

The occupant load has been calculated in accordance with **14.7.1** to be 1 824 persons. The following calculations are for a train on fire scenario with simultaneous evacuation.

All exits are assumed to be equally utilized.

Table A.1 – Data for island platform example – Travel times

Station arrangement as shown in Figure A.1, with a platform length of 183 m	Distance m	Calculation	Travel time min	Symbol
Longest travel distance to platform exit	41.5	41.5/*38*	1.09	T_p
Vertical distance from platform exit to concourse	9.1	9.1/*12*	0.76	T_v
Longest travel distance from concourse to grade exit	16.5	16.5/*38*	0.43	T_c
Total travel time to exit			2.28	T_d
NOTE Figures in italics are factors obtained from ***14.7.1****.*				

Table A.2 – Data for island platform example – Egress capacity

Station egress element	Width m	Calculation	Egress capacity persons per minute	Symbol
Standard fare gates	4 × 0.7	2.8 × *80*	224	E_1
Wide access gate	1 × 1.2	1.2 × *80*	96	E_2
Emergency exit stairs from platform	2 × 1.2 (gates to emergency stairs = 1.2)	2.4 × *56*	134	E_3
Emergency exits from concourse	2 × 1.8	3.6 × *80*	288	E_4
Escalators (speed >45 m/min)	2 × 1.0 (assume only one down running)	1.0 × *120*	120	E_5
Platform circulation stairs to concourse	2 × 1.8	3.6 × *56*	202	E_6
Total egress capacity from platform	$E_3 + E_5 + E_6$	134 + 120 + 202	456	E_p
Total egress capacity from concourse	$E_1 + E_2 + E_4$	224 + 96 + 288	608	E_c
NOTE Figures in italics are factors obtained from ***14.7.1****.*				

A.2.2.2 Platform clearance

The platform clearance time, P, is calculated from the platform occupant load, O_p, and the total egress category from the platform, E_p, as follows.

$F_p = O_p/E_p$

$F_p = 1\,824/456$

$F_p = 4.0$ min

$T_p = 1.09$ min

as $T_p < F_p$, $P = 4.0$ min

NOTE If $T_p > F_p$ then T_p would be the time for the last passenger to leave the platform and therefore platform clearance time $P = T_p$.

A.2.2.3 Evacuation to place of ultimate safety via concourse

In this example it is assumed that the place of ultimate safety is reached after leaving the paid area at the concourse or when reaching grade level via the emergency stairs.

The concourse occupant load is calculated by subtracting the numbers using emergency stairs from the total occupant load:

$$O_c = 1\,824 - (1\,824 \times (E_3/E_p)$$

$$O_c = 1\,824 - [1\,824 \times (134/456)]$$

$$O_c = 1\,288 \text{ persons}$$

Travel times to a place of ultimate safety are calculated as follows.

- Waiting time at platform exits:

$$W_p = F_p - T_p$$

$$W_p = 4.0 - 1.09$$

$$W_p = 2.9 \text{ min}$$

- Concourse flow time:

$$F_c = O_c/E_c$$

$$F_c = 1\,288/608$$

$$F_c = 2.1 \text{ min}$$

- Waiting time at concourse exits:

$$W_c = F_c - \mathrm{T}_c$$

$$W_c = 2.1 - 0.43$$

$$W_c = 1.67 \text{ min}$$

- Total travel time to a place of ultimate safety:

$$M = T_d + W_p + W_c$$

$$M = 2.28 + 2.90 + 1.67$$

$$M = 6.85 \text{ min}$$

The total time to travel to a place of ultimate safety is therefore 6.85 min.

This example was calculated assuming a train on fire with all exits available for use. For a fire within the station structure, removing the most capacious exit route (for a fire in the concourse) would result in the route through the concourse being unavailable and only the emergency exit stairs to grade could be used. However, for this second scenario, the occupant load is likely to be appreciably smaller, as it would be based on normal peak travel loads only and would not include the occupancy of a train fully laden to the normal design payload, after a delay in service. Subclause **14.7.2** gives further details for calculating occupant loads.

A.2.3 Side platforms in sub-surface station

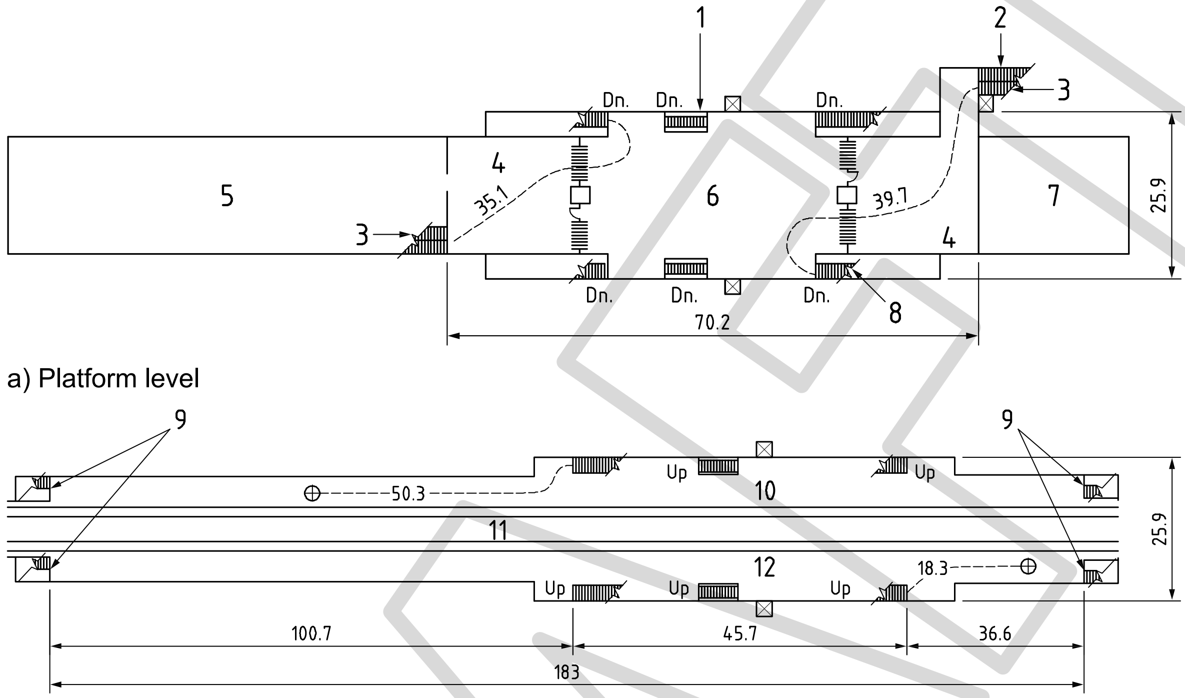
A.2.3.1 Basis of example

The following example is for a side platform in a sub-surface station with the concourse above the platform. The concourse is also below grade level. The station entrance is at grade level and is covered to a point 3 m beyond the top of the stairs.

The occupant load has been calculated in accordance with **14.7.1** to be 1 600 persons, with 260 on the outbound platform and 1 340 on the inbound platform. The following calculations are for a train on fire scenario on the inbound platform. The emergency stairs from the platform are assumed to be within a route that is fire protected up until a place of ultimate safety.

Figure A.2 – Side platform in sub-surface station

Dimensions in metres



a) Platform level

b) Concourse level

Key

1	Escalator	7	Open to platform below
2	One stair and one escalator	8	Stair
3	Up to grade level	9	Emergency stairs up to grade level
4	Free	10	Inbound platform
5	Ancillary space	11	Trainway
6	Concourse paid	12	Outbound platform

Table A.3 – Data for side platform example – Travel times

Station arrangement, assuming a platform length of 183 m	**Distance**	**Calculation**	**Travel time**	**Symbol**
	m		min	
Longest travel distance to platform exit	50.3	50.3/*38*	1.32	T_{pi}
Longest travel distance on concourse exit from outbound platform	39.7	39.7/*38*	1.05	T_{co}
Longest travel distance on concourse exit from inbound platform	35.1	35.1/38	0.92	T_{ci}
Travel distance at grade level to outside of station	3	3.0/38	0.08	T_g
Vertical distance from concourse to grade	8.0	8.0/*12*	0.66	T_{vg}
Vertical distance from platform to concourse	5.5	*5.5/12*	0.46	T_{vc}
Longest travel time from inbound platform to final exit	50.3 + 35.1 + 8 + 5.5	1.32 + 0.92 + 0.66 + 0.46	3.36	T_i
Longest travel time from outbound platform to final exit	18.3 +39.7 + 8 + 5.5	0.48 + 1.05 + 0.66 + 0.46	2.65	T_o

*NOTE Figures in italics are factors obtained from Section **4**.*

Table A.4 – Data for side platform example – Egress capacity

Station egress elements	Width m	Calculation	Egress capacity persons per minute	Symbol
Standard fare gates	14 × 0.7	9.8 × *80*	784	E_1
Wide access gate	1 × 1.2	1.2 × *80*	96	E_2
Platform circulation stairs concourse to grade level	2 × 1.8	3.6 × 56	202	E_3
Escalators from concourse to grade level (speed >45 m/min)	2 × 1.0 (assume only one is up-running)	1 × 120	120	E_4
Emergency exit stairs from platform	2 × 1.2 for each platform. (gates to emergency stairs = 1.2)	2.4 × *56*	134	E_5
Escalators (speed >45 m/min) outbound	1 × 1.0	1.0 × *120*	120	E_6
Escalator (speed >45 m/min) inbound	1 × 1.0 (assume escalator is out of service)	0	0	E_7
Platform circulation stairs to concourse from each platform	2 × 1.8	3.6 × *56*	202	E_8
Total egress capacity from inbound platform	$E_5 + E_7 + E_8$	134 + 0 + 202	336	E_{pi}
Total egress capacity from outbound platform	$E_5 + E_6 + E_8$	134 + 120 + 202	456	E_{po}
Fare/access gate restriction	$E_1 + E_2$	784 + 96	880	E_g
Total egress capacity from concourse	$E_3 + E_4$	202 + 120	322	E_c

*NOTE Figures in italics are factors obtained from Section **4**.*

A.2.3.2 Inbound platform clearance

Inbound platform clearance times are calculated as follows.

- The platform clearance time from the inbound platform, P_i, is calculated from the platform egress flow time, F_{pi}, the platform occupant load, O_{pi}, and the platform total egress capacity, E_{pi}, as follows:

  $F_{pi} = O_{pi}/E_{pi}$

  F_{pi} = 1 340/336

  F_{pi} = 4.0 min

  T_{pi} = 1.32 min

  as $T_{pi} < F_{pi}$, P_i = 4.0 min

- The waiting time to clear the inbound platform, W_{pi}, is calculated from the platform egress flow time, F_{pi}, and the travel time, T_{pi}, as follows:

  $W_{pi} = F_{pi} – T_{pi}$

  W_{pi} = 4.0 – 1.32

  W_{pi} = 2.68 min

A.2.3.3 Outbound platform clearance

Outbound platform clearance times are calculated as follows.

- The platform clearance time from the outbound platform, P_o, is calculated from the platform egress flow time, F_{po}, the platform occupant load, O_{po}, and the platform total egress capacity, E_{po}, as follows:

  $F_{po} = O_{po}/E_{po}$

  $F_{po} = 260/456$

  $F_{po} = 0.57$ min

  $T_{po} = 1.32$ min

  As $T_{po} > F_{po}$, $P_o = 1.32$ min

- The waiting time to clear the outbound platform, W_{po}, is calculated from the platform egress flow time, F_{po}, and the travel time, T_{po}, as follows:

  $W_{po} = F_{po} – T_{po}$

  $W_{po} = 0.57 – 1.32$

  The result is negative, which indicates no queuing, therefore the value is given as 0

  $W_{po} = 0$

A.2.3.4 Concourse clearance

The occupant load using the concourse from platforms is the sum of the two platforms less the evacuation load using the emergency stairs from the platforms.

Concourse clearance times are calculated as follows.

- Concourse occupant load:
  - Inbound platform:

    1 340 – (1 340 × (E_5 /E_{pi})

    1 340 – [1 340 × (134/336)] = 806 persons
  - Outbound platform:

    260 – (260 × E_5/E_{po})

    260 – [260 × 134/456)] = 184 persons
  - Total concourse occupant load = 990 persons
- Concourse flow through fare gates:

  $F_g = O_c/E_{cb}$

  $F_g = 990/880$

  $F_g = 1.12$ min
- Waiting time at fare gates:

  $W_{fg} = F_g$ – max. (F_{pi} or F_{po})

  $W_{fg} = 1.12 – 4.0$

  The result is negative, which indicates no queuing, therefore the value is given as 0

  $W_{fg} = 0$
- Concourse flow through egress elements:

  $F_c = O_c/E_c$

$F_c = 990/322$

$F_c = 3.08$ min

- Waiting time at concourse egress elements:

  $W_c = F_c$ – max. (F_g or F_{pi} or F_{po})

  $W_c = 3.08 – 4.0$

  The result is negative, which indicates no queuing, therefore the value is given as 0

  $W_c = 0$

- Total travel time to outside:

  E = max. ($T_i + W_{pi}$ or $T_o + W_{po}$) + W_{fg}+ W_c

  $E = 3.36 + 2.68 + 0 + 0$

  $M = 6.0$ min

The total time to travel to a place of ultimate safety is therefore 6.0 min.

This example was calculated assuming a train on fire with all exits available for use. For a fire within the concourse, it would normally be assumed that the exits from the platform would be unavailable, and therefore all the occupants would leave via the emergency stairs at the end of the platforms, which are a protected route to grade level. However, for this second scenario, the occupant load is likely to be appreciably smaller, as it would be based on normal peak travel loads only and would not include the occupancy of a train fully laden to the normal design payload after a delay in service. Subclause **14.7.2** gives further details for calculating occupant loads.

A.2.4 Multilevel platform stations

The procedure for calculating clearance times for multilevel platform stations is similar to the preceding example calculations.

The changes in calculations are for multilevel platform stations primarily a function of the concurrent occupant loads.

Generally, it is recommended that calculations take into account:

- the occupant load for each platform for the same time of day, establishing the worst possible load conditions; and
- the number of occupants who might be expected to have left the various levels at each egress point before this evacuation load is increased by evacuees coming from other levels.

Annex B (informative)
Firefighters lifts access and BS EN 81-72 compliance

BS EN 81-72:2015, **5.4** includes provision for rescue of trapped fire-fighters in the lift car. This annex contains a method for complying with this standard by using rope access, which is considered to be the most appropriate method in in a sub-surface station.

It is necessary to provide two anchors as these are used for rope access, i.e. the use of a working line plus a safety (back-up).

Anchors are required at the top most landing, provided that the lift shaft is no higher than 30 m.

The anchors are to conform to BS EN 795:2012, Class A1 anchor devices for rope access and rescue, rated at 15 kN in accordance with BS 7883 (not 12 kN as in BS 795).

These anchors are to be installed into appropriate structure and suitably separated so that there is no influence on each other.

The anchors need to be visible (i.e. not hidden by any cladding). If any cladding is to be provided, the covering access panel needs to be:

a) easily opened (e.g. budget lock);

b) suitably sized to facilitate access and prevent snagging points, and;

c) labelled “Fire Fighting Rope Access Point” in red type.

NOTE The anchor devices are classified as lifting equipment under Lifting Operations and Lifting Equipment Regulations 1998 [12]. As such they are subject to examination every 6 months and are required to be labelled accordingly.

Annex C (normative)
Railway train care and maintenance buildings

COMMENTARY ON ANNEX C

*General recommendations applying to all building types are given in BS 9999:2017, Section **4** to Section **9**, and Clauses **35** to Clause **37** of this standard. This annex gives additional recommendations that are specific to BS 9992, in particular, railway train care and maintenance buildings and outdoor structures such as train carriage wash, wheel lathes, controlled emission toilet (CET) sidings and fuel aprons. Such buildings need to meet both the general recommendations in BS 9999:2017, Section **4** to Section **9** (where applicable), and the specific recommendations given in this annex.*

As a general principle, the recommendations of BS 9999 can be applied to all buildings within its scope. However, in respect of certain buildings and structures (e.g. those purpose-designed to house traction rolling stock and other areas), these recommendations might be either inappropriate or unreasonably restrictive.

The design of these buildings and structures can range from fully enclosed buildings to open-roofed structures, such as under-carriage wash plant, CET sidings and fuelling aprons, and, whilst they can be large, internal divisions may be absent or incomplete. Additionally, they may characteristically have a low occupancy relative to conventional buildings of comparable size, typically not more than ten persons, who by nature of their work are familiar with the premises and the nature of the processes therein.

In such cases the recommendations given in this annex are applicable.

Attention is drawn to the Regulatory Reform (Fire Safety) Order 2005 [1], the Fire (Scotland) Act 2005 [2], the Fire Safety (Scotland) Regulations 2006 [3], and the Fire Safety Regulations (Northern Ireland) 2010 [4].

C.1 General

The recommendations given in this annex should be used for railway train care and maintenance buildings and outdoor structures such as under-carriage train washes in instances where it would be impracticable to meet the full recommendations for BS 9999:2017, Section **5** and Section **7**.

C.2 Railway train care and maintenance buildings

The following factors should be taken into account when designing process railway train care and maintenance buildings.

a) Buildings containing traction rolling stock are often distinguished from conventional buildings by greater ceiling heights, long un-compartmented structures and the presence of extensive under-carriage pits. In consequence, there is an increased chance of a person becoming aware of a fire in the early stages of its development, independent of the alarm being raised by others.

b) Whilst the magnitude of smoke production during a fire should not be underestimated, due to the nature of processes carried out in buildings of this type, the main threat to the means of escape is the potential for rapid escalation of the fire and the resultant thermal radiation. The travel distances given in BS 9999:2017, Section **5** remain applicable to these buildings; however, variations from the recommendations for conventional buildings in respect of escape route widths (see BS 9999:2017, **16.6.2**) and vertical means of escape (see BS 9999:2017, Clause **17**) might be acceptable.

c) Process areas such as wheel lathes, under-carriage washes and fuelling aprons, by virtue of their design and the nature of the process, pose a reduced threat of rapid smoke logging and also have a low occupancy. As a result, they may be provided with a single unprotected stairs or external escape stair, with alternative means of escape incorporating a combination of stairs and/or ladders, that may be internal and/or external, with walkways located at the end of the areas leading to a place of ultimate safety.

C.3 Carriage washes and under-carriage washes

NOTE The purpose of these buildings is solely to provide enclosures of the process plant to control environmental impacts and/or to protect the plant from the effects of the weather. They are typically long hangars, with openings at both ends, often with rail track installed on floors with carriage pits with headroom often less than 2 m in height.

The following factors should be taken into account when designing carriage washes and under-carriage washes.

a) Increased travel distances and enclosed horizontal components of escape might be acceptable, provided that sufficient escape routes remain unaffected during the early period of a fire to enable persons to evacuate the area safely. In these circumstances, the vertical components of the escape routes form part of the overall travel distance to a final exit. Where there is a danger of smoke logging of the unenclosed vertical components of escape within the building, external escape routes with a reduced level of fire resistance can offer a satisfactory solution, provided that the external wall in the vicinity of these provides sufficient resistance to prevent the passage of smoke and heat. The egress from this point to a place of ultimate safety should be substantially unrestricted.

b) Equally, the absence of enclosure means that alternative routes can be rapidly affected by the same incident. Therefore, unless otherwise separated to provide at least a reduced level of fire resistance, the horizontal component of alternative escape routes should be not less than 90° apart, and the vertical components should either be a minimum of 20 m apart or ascend at opposite extremities of the structure.

The travel distances for wheel lathes, carriage washes and under-carriage washes should be in accordance with Table C.1. Where exact travel distances are not known, direct distances should be taken as two thirds of the travel distance.

C.4 CET sidings and fuelling aprons

NOTE The purpose of these structures is solely to provide facilities to carry out the process of extracting effluent from stored tanks on railway train stock and to re-fuel diesel trains. They are typically long open platforms covered only by a weather protecting canopy.

The following factors should be taken into account for CET sidings and fuelling aprons, where these facilities are protected only by canopies that are open on all sides.

a) Whilst the potential for smoke logging is largely absent in CET sidings and fuelling aprons, there remains a danger to persons from the fire itself and the effects of radiated heat. Adequate means of escape to enable persons to quickly move away from a fire is, therefore, essential. A minimum of two escape routes should therefore be provided from any part of the CET sidings and fuelling aprons, sited such that they are clear alternatives, i.e. not likely to be involved in the same initial fire.

   The horizontal component of alternative escape routes should be not less than 90°, and the vertical components should either be a minimum of 20 m apart or ascend at opposite extremities of the structure.

b) The overall travel distance should be measured to a place of ultimate safety.

c) Increased travel distances for horizontal components of escape might be acceptable, provided that sufficient escape routes remain unaffected during the early period of a fire to enable persons to evacuate the area safely. In these circumstances, the vertical components of the escape routes form part of the overall travel distance to a final exit. Where there is a danger of smoke logging of the unenclosed vertical components of escape within the building, external escape routes with a reduced level of fire resistance can offer a satisfactory solution, provided that the external wall in the vicinity of these provides sufficient resistance to prevent the passage of smoke and heat. The egress from this point to a place of ultimate safety should be substantially unrestricted.

d) Equally, the absence of enclosure means that alternative routes can be rapidly affected by the same incident. Therefore, unless otherwise separated to provide at least a reduced level of fire resistance, the horizontal component of alternative escape routes should be not less than 90° apart.

The travel distances for CET sidings and fuelling aprons should be in accordance with Table C.1. Where exact travel distances are not known, direct distances should be taken as two thirds of the travel distance.

Table C.1 – Maximum travel distances for railway train care and maintenance buildings with minimum package of fire protection measure

Situation	Travel distance, in metres (m)	
	Two-way travel	One-way travel
Maintenance train shed		
Risk profile A1	65	26 A)
Risk profile A2	55	22 A)
Risk profile A3	45	18 A)
Risk profile A4 B)	Not applicable B)	Not applicable B)
Wheel lathe, carriage washes and under-carriage washes		
Normal fire hazard outdoor zone	200	60
High fire hazard outdoor zone C)		
Frequently visited	100	13
Not frequently visited	200	25
CET sidings and fuel aprons		
Normal fire hazard outdoor zone	200	60
High fire hazard outdoor zone C)		

A) This is the maximum travel distance that is allowable when the minimum level of fire protection measures is provided (see BS 9999:2017, Clause **15**). If additional fire protection measures are provided then the travel distance may be increased (see BS 9999:2017, Clause **18**), for example in respect of increased ceiling height (see BS 9999:2017, **18.3**).

B) See BS 9999:2017, Table 4.

C) Such areas are outside the scope of this British Standard unless a sprinkler system or another appropriate fire suppression system is installed to reduce the risk profile. See BS 9999:2017, Table 4 and **6.5**.

Annex D (informative)
METHANE model for incident reporting

The METHANE model, illustrated in Figure D.1, is an established reporting framework which provides a common structure for emergency responders and their control rooms to share major incident information. It is desirable for METHANE to be used when reporting all emergency incidents.

Only the emergency services can declare a major incident; the “M” is therefore omitted by the person(s) reporting the incident, and the remaining ETHANE details are passed to the emergency services.

Figure D.1 – The METHANE model

M	MAJOR INCIDENT	Has a major incident or standby been declared? (Yes / No - if no, then complete ETHANE message)	*Include the date and time of any declaration.*
E	EXACT LOCATION	What is the exact location or geographical area of the incident?	*Be as precise as possible using a system that will be understood by all responders.*
T	TYPE OF INCIDENT	What kind of incident is it?	*For example, flooding, fire, utility failure or disease outbreak.*
H	HAZARDS	What hazards or potential hazards can be identified?	*Consider the likelihood of a hazard and the potential severity of any impact.*
A	ACCESS	What are the bast routs for access and egress?	*Include information on inaccessible routs and rendezvous points (RVPs). Remember that services need to be able to leave the scene as well as access it.*
N	NUMBER OF CASUALTIES	How many casualties are there, and what condition are they in?	*Use and agreed classification system such as 'P1', 'P2', 'P3' and 'dead'.*
E	EMERGENCY SERVICES	Which, and how many, emergency responders assets and personnel are required or are already on-scene?	*Consider whether the assets of wilder emergency responders, such as local authorities or the voluntary sector, may be required.*

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For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5306-0, *Fire extinguishing installations and equipment on premises – Part 0: Guide for the selection of installed systems and other fire equipment*

BS 6164, *Code of practice for health and safety in tunnelling in the construction industry*

BS 8492, *Telecommunications equipment and telecommunications cabling – Code of practice for fire performance and protection*

BS EN 81 (all parts), *Safety rules for the construction and installation of lifts – Lifts for the transport of persons and goods*

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Other publications

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