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British Standard Code of practice for

Fire precautions in the design and construction of railway passenger rolling stock

Code de bonne pratique relatif aux précautions à prendre contre l'incendie lors de la conception et de la construction du matériel roulant de chemin de fer pour voyageurs

Leitfaden zum Brandschutz bei der Ausführung und dem Bau von Reisezugwaggons

British Standards Institution

Foreword

This code of practice was prepared under the direction of the Fire Standards Committee and is addressed to the designers of railway passenger rolling stock and those responsible for its maintenance, modification, or refurbishment. It gives advice on the choice and testing of materials, the provision of fire barriers and means of achieving safe evacuation from a train on fire.

Attention is drawn to the Health and Safety at Work etc. Act 1974, and the need to ensure that the tests described in this code are carried out under suitable environmental conditions to produce adequate protection to personnel against the risk of fire and/or inhalation of smoke and/or toxic products of combustion.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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0 Introduction

0.1 Because a moving train prevents immediate passenger evacuation from a fire except along the train itself, fires in trains may be particularly dangerous. Materials used in the construction and furnishing of coaches therefore have to be selected with particular care so that they do not easily ignite, nor release heat rapidly, nor emit more than minimum smoke and harmful combustion gases, whilst at the same time retaining the required mechanical strength of the main structure. Guidance is given on the characteristics and testing of these materials.

0.2 There is in the UK a statutory requirement for passenger trains to have a communication system by which passengers can indicate to the driver that something is wrong. On surface railways, operation of the alarm should automatically stop the train as soon as possible so that passengers can escape, but the driver should have some means to override the braking in order to stop the train at a convenient location. Resistance to fire of the materials and structure has to be such that a fire does not spread so rapidly as to jeopardize the escape of passengers before the train can be stopped.

0.3 Trains which run significant distances either underground or on elevated structures should not normally be automatically stopped by the emergency communication system; they should be stopped at the next station or at a point of access rather than in a tunnel or on the elevated structure. A train, whether or not directly involved in the fire, may nevertheless be brought to a stand in a tunnel in a fire situation, and the only means of escape is then through side or end doors and along the tunnel itself. A greater resistance to fire and its by-products is therefore required, and fire barriers should be effective for a longer time. Passengers in sleeping-car stock may also take longer to disembark and hence more stringent standards should apply, including requirements for the beds and bedding materials.

0.4 There are special risks from electrical equipment and from under-floor power units and fuel tanks, and special standards, including floor protection, are recommended where they form part of the design. There are also special risks from the use of cooking equipment, both electrical and gas, and these are also addressed, as is the provision of fire detection and extinguishing equipment.

1 Scope

1.1 This code of practice gives guidance on the design and construction of railway passenger rolling stock in respect of fire, including the choice and testing of materials and special provisions for fire protection and for means of escape, in order to minimize the hazard to passengers and crew.

1.2 The guidance covers new vehicles and changes to existing vehicles where these affect their resistance to fire.

NOTE. The titles of the publications referred to in this code are listed on the inside back cover.

2 Definitions

For the purposes of this code, the definitions given in BS 4422 apply, together with the following.

2.1 **technically competent authority.** A consultant or organization acceptable to both purchaser and vendor/manufacturer, with general experience of the interpretation of fire tests on materials and components when used in railway rolling stock.

2.2 **flammability temperature index (FTI).** The temperature at which combustion of a material is just supported in air under the conditions described in appendix A.

3 Fire hazard assessment

3.1 Vehicle categories

The vehicles of trains which require a higher resistance to fire than other trains (see 0.3) are designated as category I. This category applies to passenger trains operating in confined situations (e.g. predominantly underground or on elevated structures), to sleeping cars and couchettes, or to trains which are designed to be operated unmanned. All other vehicles are designated category II.

3.2 Product characteristics

The main characteristics by which the fire behaviour of products used in the construction should be judged are:

(a) ignitability;

(b) rate of surface spread of flame;

(c) rate of heat release;

(d) smoke generation;

(e) the nature of combustion gases and their proportions under given exposure conditions;

(f) the release of harmful products.

3.3 Design considerations

The following factors should also be taken into account when selecting products:

(a) the quantity of material which is required to be used;

(b) the position of the material in the vehicle and its configuration and orientation;

(c) how materials are combined and the possible effects of adhesives, cleaning agents, etc.;

(d) the interaction of the material with adjacent materials in a fire situation;

(e) the mechanical strength of a component in a fire, e.g. a structural member or fire barrier;

(f) the effect of air flow, either through open windows caused by train movement, or due to air conditioning/ventilation;

(g) the possible accumulation of dust or litter adjacent to the material;

(h) the proximity of possible ignition sources, e.g. diesel or electrical equipment.

3.4 Fire load density

It is recommended that the amount of combustible products used in vehicle construction is limited to the minimum practicable. Limiting the fire load density limits the overall potential severity following an outbreak of fire, although it cannot control the likelihood of a fire occurring or spreading, or its rate of increase.

4 Assessment of products

4.1 Products should satisfy the recommended test compliance criteria given in tables 1 and 2.

It should be appreciated, however, that fire is a complex phenomenon; its behaviour and its effects depend on a number of interrelated factors. The behaviour of materials or combination of materials in a fire depends upon the characteristics of the fire, the method of use of the material and the environment in which they are exposed. Relatively small-scale tests such as those described in the tables deal only with a simple representation of a particular aspect of the potential fire situation, typified by a defined heat source, and cannot alone provide direct guidance on behaviour or safety in a fire. Tests as defined may be used for comparative purposes so as to ensure the maintenance of a designated level of performance considered to have a bearing on fire performance generally but do not necessarily give an absolute indication of the fire hazard associated with the use of the material in its end product form.

The overall assessment will be modified by various factors such as the following:

(a) unusual behaviour (witnessed or recorded in the test report) which leads to the result obtained being considered unreliable by the technically competent authority (see clause 2 and 4.2);

(b) aspects of the design configuration which present the material to a possible fire source in a way different from that of the test method(s).

4.2 It is recommended, therefore, that the advice of a technically competent authority should be sought as to the extent of larger-scale testing which should be carried out, in order to avoid unreliable interpretation of small-scale test results. However, at the discretion of the technically competent authority, the recommended compliance criteria given in table 1 for the temperature index test need not be met where less than 1 kg of the product is present in any spatial cube having sides of 1 m.

4.3 Table 2 gives recommended smoke emission limits obtained for the 3 m cube test (see appendix B) for the general range of single core cables likely to be used in the construction of railway rolling stock.

The figures in the table may be used in the selection of materials suitable for cables of intermediate sizes and for multicore cables. Thus if a material or combination of materials satisfies the recommended compliance criteria when tested both as, for example, a 16 mm^2 and a 70 mm^2 cross section, then intermediate sizes may be assumed to be of acceptable smoke emission performance. For multicore cables, it has to be demonstrated that the lack of adhesion between the sheath and the cores does not cause any undesirable effects under fire conditions.

In addition, when the cables are tested in accordance with appendix B, there should be no spread of flame outside the flame impingement area, no dripping of flaming material from the cable, and no afterburn.

5 Additional testing

5.1 It is usual to carry out larger-scale testing of new components assembled in their final form to assess their fire behaviour in as realistic a manner as possible.

5.2 It is not expected that a full-scale fire test of a new coach need be carried out as a matter of routine. Components suitable for testing in isolation are:

(a) seating;

(b) bedding and mattresses (see 5.4);

(c) corner samples of floor, lower wall trim and lower end bulkhead, or of ceiling, upper wall trim and upper end bulkhead trim, including curtains and blinds, as built into the vehicle.

Where, in the opinion of the technically competent authority (see clause 2), the proposed construction represents a significant departure from the normal practice, a full-scale fire test on the actual unit or part of a unit may be deemed to be necessary. This will ensure that no unacceptable risk has been introduced due to such factors as incorporation of newly developed materials or products, interaction between components which might accelerate fire growth or the effect of ventilation conditions.

5.3 It is essential that carpets and other floor covering materials are of limited flammability and do not encourage fire spread. Flooring should be tested in conjunction with any backing or adhesive used in the horizontal position which may affect the fire performance (see note), and should withstand the following sources of ignition:

(a) burning debris falling from the ceiling;

(b) radiated heat from a ceiling, or a seat on fire;

(c) radiated heat from an underfloor electrical or oil fire. The former may include an electric arc to the underfloor metal plating which may burn through the floor locally. In this case the flooring or carpeting should not allow any local fire to spread.

NOTE. Advice on the effects of such thermal characteristics is given in appendix B of BS 476 : Part 7 : 1987.

5.4 Because of special risks associated with fire in sleeping cars, the technically competent authority (see clause 2) should ensure that the minimum of combustible materials is used in the bedding. Tests based on BS 6807 may be used. In particular, the emission of toxic decomposition products should be minimized.

5.5 Fire tests undertaken in accordance with 5.1, 5.2, 5.3 and 5.4 should be photographed at regular intervals to record and help assess the rates of fire development and smoke emission.

Table 1. Recommended compliance criteria for flammability and smoke emission testing

Product to be tested	Method of test	Compliance criteria	
		Category I	Category II
Panelling:			
Thin coating on 'inert' substrate	BS 476 : Part 6 BS 476 : Part 7 3 m cube: 60° panel test (See note 3)	$I < 12$ and $i_1 < 6$ Class 1 A_0 (ON) < 1.0 and A_0 (OFF) < 1.5	No criteria Class 1 Not defined (see note 4)
Thin coating on 'non-inert' substrate	BS 476 : Part 6 BS 476 : Part 7 Temperature index 3 m cube: 60° panel test (See note 3)	$I < 12$ and $i_1 < 6$ Class 1 > 350 °C and < 50 mm travel of flame front A_0 < (ON) 1.0 and A_0 (OFF) < 1.5	No criteria Class 1 > 250 °C and < 50 mm travel of flame front Not defined (see note 4)
'Bonded facing' on any substrate	BS 476 : Part 6 BS 476 : Part 7 3 m cube: 60° panel test (See note 3)	$I < 12$ and $i_1 < 6$ Class 1 A_0 (ON) < 2.0 and A_0 (OFF) < 3.0	No criteria Class 1 Not defined (see note 4)
Flooring:	BS 476 : Part 6 BS 476 : Part 7 ASTM–E648 Temperature index 3 m cube: flooring test (See note 3)	$I < 12$ and $i_1 < 6$ Class 1 No criteria > 350 °C and < 50 mm travel of flame front A_0 < 200	No criteria No criteria As high as possible, in no circumstances < 0.75 W/cm² > 250 °C and < 50 mm travel of flame front Not defined (see note 4)
Seating:			
Upholstered composite	BS 5852 : Part 2 using crib ignition source 7 3 m cube: seating test (See note 3)	No flaming failure and no smouldering failure (designation P7) A_0 < 9	No flaming failure and no smouldering failure (designation P7) Not defined (see note 4)
Textiles:			
Horizontal use	BS 2782 : Method 140E	Charring shall not extend for more than 50 mm across the top edge of the specimen, and there shall be no after-flame after-glow once the ethanol has burnt out.	
Vertical use	BS 5438	Burn length < 100 mm and time to extinguish < 8 s	Burn length < 100 mm and time to extinguish < 8 s
All	3 m cube: small-scale screening test (See note 3)	A_0 < 0.02	Not defined (see note 4)
Rubber/plastics:			
Solid, or flexible cellular	Temperature index (preferred) BS 2782 : Method 141A to 141D 3 m cube: small-scale screening test (See note 3)	> 350 °C and < 50 mm travel of flame front Oxygen index > 34 % A_0 < 0.02	> 250 °C and < 50 mm travel of flame front Oxygen index > 27 % Not defined (see note 4)
Rigid cellular	BS 476 : Part 6 BS 476 : Part 7 3 m cube: 60° panel test (See note 3)	$I < 12$ and $i_1 < 6$ Class 1 A_0 (ON) < 2.0 and A_0 (OFF) < 3.0	No criteria Class 1 Not defined (see note 4)
Cables:	BS 4066 Temperature index (of sheath) 3 m cube: cable test (See note 3)	Pass and no burning or glow after T + 12 s (see note 5) > 280 °C and < 50 mm travel of flame front See table 2	Pass and no burning or glow after T + 12 s (see note 5) > 280 °C and < 50 mm travel of flame front Not defined (see note 4)

NOTE 1. The temperature index test and 3 m cube smoke emission tests referred to in this table are fully described in appendices A and B respectively. Both have been shown by experience to quantify effectively those fire characteristics of a product of major importance in fires in the environment under consideration, and at present no equivalent British Standard fire tests are available. It is, however, envisaged that the temperature index test, designed as a 'material' test only, will eventually be replaced by a 'rate of heat release' test, when such a British Standard is published as part of the 'reaction to fire' series. For the temperature index test, attention is drawn particularly to A.1.

NOTE 2. Units of absorbance (A_0) are square metres per unit of material. The unit of material varies depending on the type of test.

NOTE 3. For the 60° panel test, the 'burn area' is 0.15 m². For the flooring test the units are square metres. For the seating test the 'burn area' is approximately 0.1 m². For the screening test the units are grams (normally). For the cable test the 'burn length' is 20 cm.

NOTE 4. In category II vehicles, where side evacuation of passengers is normally possible, the significance of smoke limits has not yet been evaluated and thus no figures are currently given.

NOTE 5. T is the period for which a flame is applied to the sample and is defined in clause 7 of BS 4066 : Part 1 : 1900

Table 2. Recommended compliance criteria in respect of smoke emission from single core cables

Conductor cross section	Test array		Compliance criteria A_o* (max)		
	No. of strands in bundle	No. of bundles	ON	OFF	OFF–ON
mm^2					
1	7	4	0.050	0.075	0.025
4	7	3	0.20	0.30	0.10
16	1	6	0.30	0.45	0.15
70	1	4	0.40	0.60	0.20
240	1	2	0.80	1.10	0.30

* The units of absorbance (A_o) are square metres per 'burn length'.

6 Smoke and toxic gases

6.1 Small samples may be tested to give an indication of the emission of smoke using the method described in BS 6401. This method does not however give a reliable indication of the behaviour of a large sample or group of components which should be separately tested using the 3 m cube test (see appendix B).

6.2 Although limiting the emission of toxic gases is very important, there is at present no suitable method relating gas emission to toxic hazard (see note). Until one is available, the designer should be aware that some products may rapidly generate carbon monoxide and other toxic gases in a fire, and that it is important these products are avoided, especially in category I vehicles.

NOTE. A British Standard code of practice on the assessment of toxic hazards in fire is in preparation and when available its guidance should be used.

7 Preventing or delaying the spread of fire and its products

7.1 Apart from the exceptions given in 7.4, transverse fire barriers should be provided at the ends of coaches or within their length, to prevent or limit the spread of fire or combustion products from one vehicle to another or along the insides of vehicles, so that passengers can escape from the scene of the fire before the vehicle comes to a stand. A fire barrier should extend to the vehicle's outer walls and roof, and to the floor or any underfloor barrier provided; it should have as few apertures as practicable and these should be sealed to the same standard of integrity as the rest of the barrier. Transverse fire barriers should provide a minimum integrity of 20 min on category I vehicles, and 10 min on category II vehicles, when tested in accordance with BS 476 : Part 22.

7.2 Transverse fire barriers should extend through voids between the trim ceiling and the vehicle roof. In sleeping cars and couchettes the void should also be divided by sealed vertical barriers into spaces which are not more than 3 m in length.

7.3 Doors fitted within transverse fire barriers should have the same standard of fire resistance (see 7.1), and be fitted with flexible edge seals to control smoke movement at ambient temperatures. Where air louvres need to be incorporated for air conditioning or ventilation purposes, they should be as near to the floor as practicable, and any drop lights should be self-closing.

Such doors should normally be kept closed or be self-closing. Alternatively, they may be held open and automatically released when a fire alarm or passenger alarm is operated; such an arrangement may be used on sleeping car vehicles.

7.4 Corridors in sleeping cars should be divided into portions not exceeding 15 m in length by transverse fire barriers (see 7.1) with smoke control doors (see 7.3). Transverse fire barriers should also be provided each side of any cooking area, and to separate the guard's compartment from the passenger accommodation.

7.5 Where electrical underground trains are designed with full-width access between cars (e.g. with articulated bogies) in order to carry very high density commuter traffic, it may be acceptable in case of fire to dispense with transverse barriers in order to speed the evacuation of the train out of its end doors. This is acceptable on condition that all internal surfaces within the vehicle's main compartments should be constructed of materials of limited combustibility, in accordance with BS 476 : Part 11.

NOTE. The provision of glazing in doors in category II vehicles is at the discretion of the technically competent authority.

7.6 If the floor construction itself does not provide an effective horizontal fire barrier, an additional barrier should be provided to separate passenger/crew accommodation from underfloor fire sources. An indicative fire resistance test, exposing a representative sample of the complete barrier to the time/temperature conditions specified in BS 476 : Part 20, should be carried out, and the integrity and insulation criteria given in this test should be complied with for 30 min.

In the case of underfloor mounted diesel engines, this construction should be designed so that oil cannot seep above it. Where ducts and trunking penetrate a fire barrier,

the ducting should be capable of maintaining its integrity in a fire situation. The ducts should also be fire-stopped into the barrier, and should be as few as possible in number.

7.7 Heaters in passenger and crew areas should be so designed or protected that the air flow around them cannot be accidentally obstructed, and in any case no part of the external surface of the heater should exceed 150 °C, even if ventilation holes in the casing guarding the heater become accidentally blocked. All combustible material in the vicinity of heaters should be protected.

7.8 Care should be taken to ensure that ventilating fans do not recirculate combustion products to passengers in the event of a fire; this particularly applies to sleeping cars.

7.9 In compartments where smoking is allowed, an appropriate number of integral ashtrays should be provided, but preferably not as part of upholstered seats or furnishings.

8 Special provisions for cleaning

8.1 Inside and outside the vehicle, the design should avoid introducing ledges or cavities which allow litter or oily waste to accumulate.

8.2 Air conditioning and ventilation systems and ducts should be designed so that they can be easily cleaned.

8.3 Heater enclosures should be designed to inhibit dirt ingress, and prevent retention of any that does enter.

9 Special provisions for internal combustion engines

9.1 Horizontal fire barriers should be in accordance with 7.6.

9.2 All engine compartments/bays should be provided with an automatic fire detection system with 'maximum temperature' detectors, with or without 'rate-of-temperature rise' elements. The system should be sensitized whenever a vehicle is in normal service. Engine compartments should also be fitted with a suitable automatic fire extinguishing system, in accordance with the relevant Part of BS 5306.

Where the engine is not enclosed, the fire extinguishing system should not operate until the train speed is so reduced that the fire extinguishing media is not dispersed.

9.3 Fuel and lubricating oil systems and pipework, including compressors, should not be sited in the same equipment bay as electrical equipment. The ends of equipment bays containing engines and fuels should constitute a fire barrier in accordance with 7.6.

9.4 The design of oil and fuel tanks should ensure that during filling or draining, or in the event of leakage from a tank or its pipework, flammable liquids cannot seep into any electrical equipment or into any insulating or lagging material which may act as a wick. Leaks should be collected in a drainage tank of adequate capacity which can be easily emptied during servicing.

9.5 Absorbent lagging should be covered by an impervious sheath which should itself be flame retardant. It is advisable to leave valves and flanges unlagged because of the risk of leakages and to facilitate inspection and maintenance.

9.6 Oil and fuel tanks should be so located or protected that they or their piping cannot be punctured or fractured by failed mechanical equipment, or by debris thrown up from the track.

10 Special provisions for electrical equipment and wiring

10.1 All cables should be of sufficient capacity for their intended duty.

10.2 Circuit protection devices (e.g. fuses or circuit breakers) should be fitted to all poles of a circuit (except the earth or neutral pole) to prevent sustained overcurrents and short circuits. The cable size, load current and fuse/circuit breaker setting should be appropriately related.

10.3 All cable terminations should be of a type which will maintain good continuity and which will not shake loose. Particular care should be taken to ensure that power-cable connections are properly secured.

10.4 On underground railways, main power 'bus' cables or electrically or mechanically unprotected power cables should not be carried between cars, unless these cars are permanently coupled or share a common bogie, and the cables are permanently connected to each car. On railways for which the power supply is via positive and negative conductors, and where main power 'bus' cables are electrically unprotected except by the sub-station line breakers, cables of opposite polarity should be separated by a distance sufficient to ensure that an arc resulting from a fault condition is not maintained, and should be separated from earthed surfaces by a suitable arc-resisting barrier. Where the earth return is via the running rails, electrically unprotected cables should be sheathed in an earthed metal conduit, so that if cable damage or a fault occurs, a low impedance path to earth is created.

10.5 All power cables should be protected against accidental damage and from fretting at points where they emerge from conduits and enclosures.

10.6 Special fire barriers should be fitted between the vehicle and possible sources of sustained arcing, e.g. electrically unprotected power cables.

10.7 Equipment with heat outputs capable of initiating a fire or which produce arcs should be well ventilated and shielded from other equipment, and where appropriate, heat and fire barriers should be fitted between the equipment and the vehicle.

10.8 Metal boxes, cases, enclosures and panels containing electrical equipment should be earthed. Looped earthings between equipment should be avoided.

10.9 Means should be provided, in case of fire, to isolate all electrical supplies to the train (either on the train or externally to the train) and to isolate equipment of large current-carrying capacity.

10.10 Electrical surface creepage and electrical clearance distances should comply with BS 2618.

10.11 All lamps and lamp fittings should comply with BS 4533 : Part 101 and should be placed or guarded to prevent ignition of any materials fitted or placed nearby.

10.12 Vehicles with high-voltage (e.g. 1000 V d.c.) equipment liable to be exposed in a fire should have switches isolating all high voltage circuits located close to any fire extinguisher. A warning notice readily understood by the public should be clearly displayed close by.

10.13 Boxes containing batteries liable to give off flammable gases should be safely ventilated and the exterior and interior should be clearly marked to show that smoking and the use of naked lights is prohibited. The design of the battery circuits should take into account the high level of current flow resulting from a short circuit.

11 Special provisions for cooking equipment

11.1 General

All cooking appliances, irrespective of type, should be adequately insulated to prevent conduction of heat to adjacent surfaces and equipment; all surfaces surrounding cooking appliances should be adequately insulated against the effects of heat radiation from appliances.

11.2 Gas installations

11.2.1 Gas cylinders and the appliances they serve should be on the same vehicle. Not more than two gas sources should be installed on a vehicle (one in use and one in reserve), each source comprising no more than four gas cylinders. Cylinders should have a maximum capacity of 14 kg and should be clearly marked to show the type of gas contained.

11.2.2 Separate gas sources should be securely housed in separate steel or steel-clad boxes mounted below the floor level of a vehicle. These boxes should have ventilation holes in their base sufficient to allow a complete discharge of gas from all the cylinders in the box to escape to open air without a build up of pressure. The exterior of such boxes should be clearly marked to show that they contain gas cylinders and the exterior and interior should be clearly marked to show that smoking and the use of naked lights is prohibited.

11.2.3 The high-pressure section of a gas supply system, to the pressure regulator, should be situated below the floor level of the vehicle, with no access to such equipment from within the vehicle, and should contain a non-return valve and also a valve which will cut off the gas supply if a pre-set flow rate is exceeded. The regulator and both valves should be positioned in the gas line, as close to the supply cylinders as possible.

11.2.4 Metallic pipework external to gas cylinder boxes should be as short as possible, have the minimum number of joints, and not be subjected to high temperatures.

11.2.5 A main isolating cock should be provided in each compartment containing gas appliances. These cocks should be situated as close as possible to the point of entry of the supply into the compartment, with no joints between the point of entry and the cock, and should be visible, easily accessible and clearly labelled to define their purpose and direction of operation.

11.2.6 A cut-off device should be fitted immediately adjacent to, and on the appliance side of, each main isolating cock. This device should isolate the gas supply should a pressure differential exist across the device. No intermediate isolating cocks should be fitted on the appliance side of this device and each burner should be controlled by only one cock beyond this point.

11.2.7 Each burner that is concealed or whose flames are not clearly visible during normal operation should have a device fitted on the gas supply; this device should isolate the gas supply to the appliance when any of its pilot burner flames (or, if pilot burners are not fitted, any of its main burner flames), are accidentally extinguished.

11.2.8 Water-filled gas appliances should be equipped with a device which will isolate the gas supply when the water level falls below the minimum safe level.

11.2.9 Flues from gas appliances should exhaust outside the vehicle and should be adequately insulated from any adjacent surfaces.

11.2.10 Suitable ventilation should be provided to all compartments which contain gas-fuelled appliances, to allow complete combustion with no deficiency of oxygen in the atmosphere.

11.2.11 Floor and roof level outlets should be provided to allow products of combustion and unburnt gas to escape from the vehicle.

12 Aiding passenger and crew escape

12.1 All trains should have doors which can be used for emergency exit. In the case of stock designed for running on routes where side exit is not possible, the emergency doors should be at the end of the train, and there should be access throughout the train. Doors leading into driving compartments may be kept locked, on condition that provision is made for emergency access by passengers (e.g. a handle, secured to the door locking mechanism, under a frangible cover).

12.2 Where accommodation for disabled people is provided, their egress in emergency should be considered.

12.3 In addition to provision on intermediate vehicles, there should be emergency doors on both sides of the train, at each end of each group of vehicles having through access beyond which there is no access into the remainder of the train. These doors should be located not more than 6 m from the dead end.

12.4 In the case of power operated doors, and where end egress is not available, provision should be made for emergency doors to be opened by passengers from inside

the vehicle. Automatic smoke-stop doors (see 7.3) inside a vehicle should be able to be opened from either side, even if the power or operating mechanism has failed. How a door opens (i.e. by pushing or by sliding) should be indicated on the door.

12.5 Swinging doors should, where possible, open towards the nearest external door but may be arranged to open in both directions. It should be clear how a door can be opened by hand.

12.6 All passenger and crew areas should have emergency lighting available for 1 h after the main lighting system has failed. The level of illumination should be not less than 30 lx in the vicinity of emergency exit doors, and not less than 5 lx along passenger and crew walkways.

12.7 Where windows are fixed, some means of escape should be provided, such as readily accessible hammers with hardened points distributed as follows:

(a) at least two for each open passenger vehicle;

(b) at least one per passenger compartment or sleeping compartment;

(c) at least one in each crew area where escape via a window is possible.

Hammers may be released on pulling an emergency alarm handle (communication cord) or by breaking open a container in which they are displayed. Quickly read and easily understood instructions for their use should be displayed.

12.8 Adequate provision should be made for the stowage of passenger luggage clear of the main vestibules, exits and passages.

12.9 Each passenger-carrying vehicle and each driving cab should contain an easily accessible suitable fire extinguisher(s) in accordance with BS 5423. Each cooking area should be provided with a fire blanket in accordance with BS 6575 and a suitable fire extinguisher as above.

12.10 Each sleeping car, couchette or pantry should be fitted with an automatic smoke or heat detector which should be sited in accordance with BS 5839 : Part 1.

Upon operation, it should give an automatic alarm in the affected compartment. In addition, an indication of the alarm should be given in the pantries and other accommodation occupied by the attendants, including adjacent cars. The audibility of the alarm should also be in accordance with BS 5839 : Part 1. The alarm should indicate to the attendants the number of the affected compartment.

An additional smoke detector should be sited within the coach ventilation system, and the actuation of this detector should alert the entire coach. The provision of a special visual signal in certain compartments for the use of deaf passengers should be considered.

12.11 It is important that passengers are made aware of the proper action to take in the case of fire. The location of the emergency alarms and of fire extinguishers should be clearly indicated by notices. Where certain doors are to be used as emergency exits, these too should be clearly indicated as such. Other instructions may best be given to passengers by the train crew using the public announcement (PA) system if provided. These may include instructions to disembark from one or other end of a train, or on the safe side of a train away from adjacent lines; the availability of fire extinguishers and their location, and the location and use of devices to be used to break or otherwise open windows for emergency evacuation of a train in which the end doors are obstructed. Instructions to remind train crews to give such advice should be provided adjacent to the PA system microphone, or at some other suitable place.