

BS 7346-8:2013



BSI Standards Publication

Components for smoke control systems

Part 8: Code of practice for planning, design, installation, commissioning and maintenance

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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 31 December 2013. It was prepared by Technical Committee FSH/25, *Smoke, heat control systems and components*. A list of organizations represented on this committee can be obtained on request to its secretary.

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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.

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.

Departures from the recommendations of this British Standard are possible through consultation and discussion, and with the agreement of all interested parties (see 5.2).

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.

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.

0 Introduction

Smoke control systems create and maintain a smoke-free layer above the floor, or help to reduce smoke and heat build-up, by removing smoke and hot gases released by a fire in the development stage. In doing this, smoke control systems help to:

- a) keep escape and access routes free from smoke;
- b) facilitate firefighting operations;
- c) delay and/or prevent flashover and thus full development of the fire;
- d) protect equipment and furnishings;
- e) reduce thermal effects on structural components during a fire; and
- f) reduce damage caused by thermal decomposition products and hot gases.

The use of smoke control systems has become widespread. Their value in assisting in the evacuation of buildings, reducing fire damage and financial loss by preventing smoke logging, facilitating firefighting, reducing roof temperatures and retarding the lateral spread of fire is firmly established. For these benefits to be realized, however, it is essential that smoke control systems operate fully and reliably whenever called upon to do so during their installed life.

A smoke control system is made up of components that have generally been tested to recognized European and International standards, and needs to be installed as part of a properly designed system. The most relevant standards applicable to smoke control systems are BS EN 12101 and BS ISO 21927. Typical system implementation involves the selection of appropriate products, suitable deployment of these products and ensuring they are then interconnected and controlled in such a way as to meet the design criteria.

The recommendations for the design, planning, installation, commissioning, use and maintenance of a smoke control system are set out in the order given in Figure 1.

The first step in the design process is to assess the needs of the building for a smoke control system (see Clause 5). When a decision is taken as to the type and purpose of the system, the planning and detailed design process begins (Clause 6).

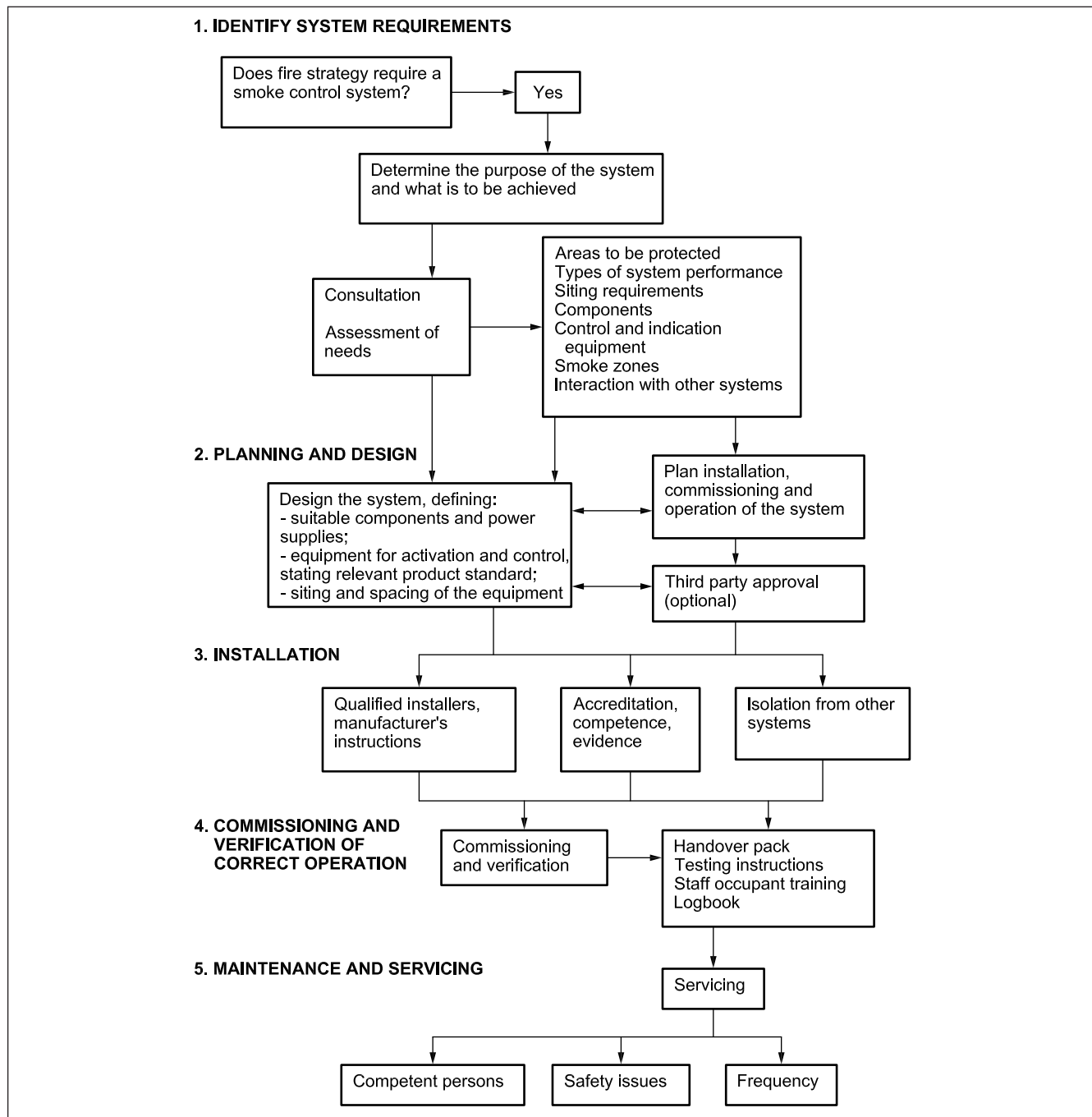
The third step is installation, which includes mounting and interconnecting the components (see Clause 7).

The fourth step is the commissioning of the system and verification of correct operation (see Clause 8).

Once the smoke control system is handed over to the relevant responsible person, it is important that the system is maintained and serviced to ensure it remains fully operational (Clause 9).

The statutory responsibilities for a smoke control systems are set out in Annex A. Annex B provides model certificates for the various steps of an installation, while Annex C provides a model format of a system logbook. Annex D contains figures relating to the location of roof ventilators in areas potentially subject to positive pressures.

Figure 1 Process for planning, designing, installing, commissioning and maintaining a smoke control system



1 Scope

This British Standard gives recommendations for the planning, design, installation, commissioning and maintenance of smoke control systems, including smoke clearance, in and around buildings. The recommendations are applicable to systems intended for the protection of life and/or protection of property, including:

- a) natural smoke ventilation;
- b) mechanical smoke ventilation;
- c) smoke barriers;
- d) smoke and heat exhaust ducts;
- e) smoke dampers, and

their controls, power supplies and interconnections.

This British Standard is not applicable to non-fire-related functions of smoke control systems.

This British Standard does not give recommendations as to whether or not to install smoke control systems in any given premises.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 5839-1, *Fire detection and fire alarm systems for buildings – Part 1: Code of practice for design, installation, commissioning and maintenance*

BS 7346-4:2003, *Components for smoke and heat control systems – Part 4: Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing steady-state design fires – Code of practice*

BS 7346-5, *Components for smoke and heat control systems – Part 5: Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems, employing time-dependent design fires – Code of practice*

BS 7346-7, *Components for smoke and heat control systems – Part 7: Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks*

BS 7671, *Requirements for electrical installations – IET Wiring Regulations*

BS 8519:2010, *Selection and installation of fire-resistant power and control cable systems for life safety and fire-fighting applications – Code of practice*

BS 9991, *Fire safety in the design, management and use of residential buildings – Code of practice*

BS 9999:2008, *Assistive products for persons with disability – Classification and terminology*

BS EN 1366-3, *Fire resistance tests for service installations – Part 3: Penetration seals*

BS EN 12101-1, *Smoke and heat control systems – Part 1: Specification for smoke barriers*

BS EN 12101-7, *Smoke and heat control systems – Part 7: Smoke duct sections*

BS EN 12101-8, *Smoke and heat control systems – Part 8: Smoke control dampers*

BS EN 12101-10:2005, *Smoke and heat control systems – Part 10: Power supplies*

BS EN 60335-2-103, *Household and similar electrical appliances – Safety – Part 2-103: Particular requirements for drives for gates, doors and windows*

BS EN 60947 (all parts), *Low-voltage switchgear and control gear*

BS ISO 21927-9, *Smoke and heat control systems – Part 9: Specification for control equipment*

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 access level

one of several states of control equipment in which selected:

- controls can be operated;
- manual operations can be carried out;
- indications are visible;
- information can be obtained

[SOURCE: BS ISO 21927-9]

3.2 aerodynamic free area

geometric area multiplied by coefficient of discharge

3.3 air inlet

device connected to outside air to admit air from outside the premises

3.4 automatic activation

initiation of operation of the smoke control system without manual action

3.5 coefficient of discharge

C_v

ratio of actual flow rate, measured under specific conditions, to the theoretical flow rate through the natural SHEV as defined in Annex B of BS EN 12101-2:2003

3.6 commissioning

act of ensuring that all components and the smoke control system are installed and operating as planned

3.7 component

complete product that is part of the smoke control system

NOTE The principal types of smoke control components are:

- *natural smoke and heat exhaust ventilators;*
- *mechanical smoke and heat exhaust ventilators (fans);*
- *smoke barriers;*
- *smoke control duct sections and ancillaries;*
- *smoke control dampers;*
- *control equipment;*
- *power supplies, including cables;*
- *air inlet.*

3.8 control equipment

element containing control and/or release devices, manual and/or automatic, used to operate the smoke control system

3.9 fire compartment

enclosed space, comprising one or more separate spaces, bound by elements of construction having a specified fire resistance and intended to prevent the spread of fire (in any direction) for a given period of time

NOTE "Fire compartment" often has regulatory connotations. The term is not to be confused with "room of origin" or "fire cell".

3.10 fire position

position of a component to be reached and maintained while the smoke control system is venting smoke and heat

3.11 geometric area**Av**

area of the opening through a ventilator, measured in the plane defined by the surface of the building, where the surface of the building contacts the structure of the ventilator

NOTE No reduction is made for controls, louvres or other obstructions.

3.12 initiation device

device, e.g. control panel, which activates the operating mechanism of a component (e.g. a smoke control damper or ventilator) on receipt of information from a fire or smoke detection system or thermal device

3.13 manually initiated smoke control system

smoke control system which is initiated by human actions after the outbreak of fire (e.g. by pressing a button or pulling a handle), leading to a sequence of automatic actions that operate the smoke control system

3.14 natural ventilation

ventilation caused by buoyancy forces arising from differences in the density of gases due to temperature differences

3.15 operating time

maximum period between the signal to operate being received by the smoke control system and the achievement of the fire position by the smoke zone of the component with the most unfavourable route

3.16 powered ventilation

ventilation caused by the positive displacement of gases through a ventilator

NOTE Powered ventilation is usually provided by fans.

3.17 premises management

persons having day-to-day control of the premises, the fire safety system(s) and implementation of the fire procedures

NOTE In large premises, management for the fire safety system and associated matters is often delegated to a single person with specialist knowledge. In small premises, a person with specialist knowledge is unlikely to be present, but management of the fire safety system can still be delegated to a specific person.

3.18 response time

period between the signal to operate being received by a component (e.g. a control panel, ventilator or smoke control damper) and the achievement of the component's fire position

- 3.19 secondary power supply**
power supply to operate the smoke control system when the primary power supply has failed
- 3.20 single-operation system**
automatic natural smoke control system which offers no firefighting facility to change the system status after initial activation
- 3.21 smoke and heat exhaust system**
arrangement of components that exhausts smoke and heat from a fire in a building or part of a building
- 3.22 smoke and heat exhaust ventilation system
SHEVS**
set of components jointly selected to exhaust smoke and heat in order to establish a buoyant layer of warm gases above cooler, cleaner air
- 3.23 smoke and heat exhaust duct**
component used to channel gases to and from the smoke and heat exhaust ventilator
- 3.24 smoke and heat exhaust ventilator
SHEV**
device specially designed to move smoke and hot gases out of a building under conditions of fire
- 3.25 smoke control damper**
device which can be opened or closed to control the flow of smoke and hot gases
NOTE A smoke control damper can have the following positions.
a) *Fire position: open (to exhaust smoke from fire compartment); closed (to avoid spreading of smoke in other zones).*
b) *Standby position: closed or open for exhaust fume ventilation.*
- 3.26 smoke control system**
arrangement of components installed in a building to limit the effects of smoke and heat from a fire
- 3.27 smoke layer**
layer of smoke which stabilizes underneath the roof due to the effect of temperature gradients
- 3.28 smoke reservoir**
volume within a building limited or bordered by the ceiling and smoke barriers or structural elements so as to retain a thermally buoyant smoke layer in the event of a fire
- 3.29 smoke zone**
geographical subdivision of the protected building served by a smoke control system (or sub-system of a smoke control system), which is initiated by a signal from a single device or group of initiation devices associated with the zone
NOTE A zone contains at least one smoke reservoir.
- 3.30 standby position**
state of a component ready for operation

3.31 thermal device

temperature sensitive device which responds to heat by initiating a subsequent action

4 Documentation and responsibility

4.1 Documentation

Proper performance of each stage of the work should be fully documented by the person or organization taking responsibility for that stage. The documentation should include as a minimum:

- a) design criteria;
- b) cause and effect;
- c) description of operation;
- d) schematic;
- e) as-built drawings;
- f) operation and maintenance manuals
- g) certificates;
- h) logbook.

NOTE Current legislation, e.g. the Building Regulations [1, 2, 3], requires the person carrying out the work to pass on all the fire safety information about the system, as installed. This is because the building user needs to know how to safely operate and maintain any fire safety equipment. The design and installation details form the basis of any records for risk assessment purposes.

4.2 Responsibility

Responsibility for the planning, design, installation and initial performance of the installed system should be clearly defined and documented.

The design, installation and commissioning of the smoke control system may be undertaken by a single organization, or by different organizations. For example, the designer and installer may be a single, specialist smoke control contractor. Alternatively, the relevant responsible person may be responsible for the design of a smoke control system (which might be undertaken by consultants acting on behalf of the responsible person), and the design may then be communicated, by means of a specification and/or drawings, to a specialist smoke control contractor and/or to an electrical installation contractor, which would, in either case, then be responsible for installation. Responsibility for each of these activities should be agreed and documented prior to the commencement of the installation work.

Various contractual arrangements are possible, but overall responsibility for checking compliance with this standard and that the performance of the system matches the design requirements should be assumed by one organization. This responsibility should be agreed prior to the start of the installation contract.

The responsibility for provision of appropriate documentation to the relevant responsible person following completion of the system (see **8.2** and **8.3**) may rest with more than one organization and should be defined before an order for the system is placed. The type of documentation to be provided should be defined in the contract for design, supply, installation and commissioning.

NOTE The statutory responsibilities for a smoke control systems are set out in Annex A.

5 Determining requirements for a smoke control system

5.1 Assessment of requirements

The designer should determine whether a smoke control system needs to be incorporated into the overall fire safety strategy for the building and, if so, the purpose of the system (e.g. protect means of escape, facilitate firefighting access or protect property) and what is to be achieved.

An assessment may include the following.

- a) Whether part or all of the building is to be protected.
- b) The type of system to be installed.

The system should be designed to meet the requirements of the overall building fire safety strategy.

5.2 Consultation

Where the installation of a new smoke control system, or an extension or alteration to an existing smoke control system, is being considered for a new or existing building, the following should be consulted and, where necessary, their approval sought.

- a) The building control body.
- b) The fire authority.
- c) The insurer(s) of the building.

The consultation should cover:

- 1) the purpose of the system (see 5.1);
- 2) the areas to be protected;
- 3) selection of the correct type of system;
- 4) subdivision of the building into smoke zones;
- 5) components;
- 6) the siting requirements for the various parts of the building;
- 7) provision for control of the system and for the display of its indications;
- 8) provision of primary and secondary power supplies;
- 9) interaction with other systems, especially the interaction with fire suppression systems.

6 Planning and design

6.1 General

To ensure successful installation, commissioning and operation of the system, these processes should be carefully planned and designed, addressing the following as necessary.

- a) Subdivision of the building into fire compartments and smoke zones.
- b) Component selection and compatibility.
- c) Siting and spacing of equipment.
- d) Interactions.
- e) System activation.

- f) Control and indication requirements, including hierarchical operation and functionality.
- g) Location of control equipment.
- h) Power supply selection and performance.
- i) Cable selection and performance.
- j) Pneumatic pipework selection and performance.
- k) Smoke control ductwork selection and performance.

6.2 Smoke zones and smoke reservoirs

6.2.1 General

The building or space within the building should, as required by the fire strategy, be divided into smoke zones arranged so that smoke from any fire can only enter one smoke zone. Fire compartmentation should not be compromised by the operation of the smoke control system.

Smoke zones should take into account the internal layout of the building space and the layout of the contents where this is fixed.

Where the fire strategy requires different smoke zone operation depending upon the fire location, the smoke zones should be interlinked with the fire detection zones to ensure correct operation.

NOTE A fire compartment within a building might require one or more smoke zones.

6.2.2 SHEVS

The dimensional limits of each smoke zone should be established in accordance with BS 7346-4 and BS 7346-5.

NOTE The recommended smoke zone area limits of 2 000 m² and 2 600 m² are not absolute maxima, but are considered small enough that the effects of cooling of the smoke layer can be neglected. If larger zones are required these ought to be justified by calculation or modelling.

6.2.3 Car parks

Where a smoke control system is recommended for a car park the dimensional limits for each zone should be determined in accordance with BS 7346-7.

NOTE There is no limit on smoke zone size for car parks. Smoke zones are, however, commonly limited to one level of the car park, and in large car parks each level may be separated into more than one smoke zone. This has the benefit of reducing the area likely to become smoke logged, and can reduce plant space and cost.

6.2.4 Single storey, multi-storey buildings and buildings with atria

Where a smoke control system is recommended the system should be designed in accordance with BS 9999, BS 9991, BS 7346-4 and/or BS 7346-5, as applicable.

6.3 Selection of components

Suitable mechanical and electrical system components should be selected to meet the intended design criteria under the defined fire conditions for the system. The system design documentation (e.g. performance specification) should reference the applicable product standards.

The components selected should be sized to ensure they have sufficient capacity or functional capability to achieve the design performance, including adequate reserve capacity. Only components that have been tested to product standards should be selected, e.g. BS EN 12101 and BS ISO 21927.

NOTE 1 The Construction Products Regulation [4] requires manufacturers to supply only fire safety products that are CE-marked as a construction product where harmonized standards exist. CE marking is not required outside the EU.

NOTE 2 BS EN 12101 and BS ISO 21927 were produced specifically for products intended for use in smoke control systems. Products assessed for fire performance only might not necessarily meet smoke control requirements.

There are many components that can be installed and interconnected to make up a smoke control system. The selection of the most appropriate type of component should be based on such factors as the following.

- a) The component performance required to satisfy the system design intent, e.g. time and temperature rating of fans, airflow rates, and aerodynamic free area for ventilators.
- b) Building use:
 - 1) high risk (e.g. warehouse containing flammable materials);
 - 2) low risk (e.g. office accommodation).
- c) Size of area to be protected by a system. Large areas might need to be subdivided into zones by smoke barriers.
- d) The building structure, location and available space.
- e) Smoke control components with fire-resisting classification might be needed to ensure the correct function of the system without compromising the compartmentation of the building.
- f) The complexity of the control system. Complex buildings require complex control systems containing multiple zones, automatic activation, initiation of different smoke control components, high degree of firefighter control and override, and detailed system information (e.g. zoned status indication). Manual activation only, e.g. via a manual control point, might be suitable for simple systems.
- g) The need to ensure compatibility of components by ensuring that individual components:
 - 1) are individually fit for the purpose they are intended to perform;
 - 2) interact with each other to achieve the system design intent;
 - 3) do not adversely and disproportionately affect the operation of the system upon failure of a single component;
 - 4) interact with other fire protection measures where necessary to achieve the overall fire strategy.

NOTE 3 Common issues such as incompatible voltages, electrical loads and communication protocols can be avoided by considering these factors at the planning and design phase.

For systems other than single-operation, the smoke control system should be capable of maintaining functionality to serve active systems for protecting and assisting firefighters in their role for at least 60 minutes, depending on the specific firefighting application.

NOTE 4 It is important that the system design clearly defines the performance criteria of the system during all phases of operation, including firefighting, and that those performance criteria are reasonable and achievable. Performance criteria which cannot be met by using products tested to BS EN 12101 or BS ISO 21927 need to be avoided (see 6.7.3).

NOTE 5 BS 8519 gives further information on fire survival time of cables for firefighting applications.

Any component of the smoke control system selected for purposes other than smoke control should not under fire conditions prevent the smoke control system from performing its emergency design function when required. The operation of the smoke control system should be given priority over non-emergency functions of the system.

6.4 Siting and spacing of equipment

6.4.1 General

Equipment should be installed in accordance with the manufacturer's instructions, and sited so that smoke and heat from any fire can be exhausted from the smoke zone without undue dilution or delay. The equipment should be sited to ensure that it does not adversely interact with other firefighting systems or that other systems do not prevent the operation of the smoke control system.

Smoke exhausts should be designed and located so that the discharged smoke is not directed at adjacent building surfaces and is unlikely to re-enter the building or adversely affect escape routes.

6.4.2 Tamper resistance

Where equipment is located in areas susceptible to inappropriate operation or tampering, sufficient measures should be taken to prevent or minimize the risk of such interference. These measures may include installing additional tamper-evident protective covers, elevated access levels or limiting control functionality to essential operation only.

6.4.3 Maintenance access

Provision should be made for access for maintenance purposes. All installed components should be capable of being safely maintained and cleaned. Access should be planned for routine maintenance tasks and plant replacement. The plant replacement strategy should be documented.

Clearance should be provided for all moving parts of the equipment to move through the designed operating range without obstruction from any other fixed or moving part of the building.

6.4.4 Climatic and environmental consideration

As any part of the smoke control system may be installed inside or outside buildings under various climatic and environmental conditions, and exposed to possible accidental or wilful mechanical damage, all the conditions under which the system is required to operate should be fully determined and any associated risks to correct electrical and mechanical operation should be reduced to acceptable levels.

Care should be taken to ensure the environment is maintained within the required temperature range and ventilation recommended by the smoke control equipment manufacturer.

The environmental conditions at each location and measures required to prevent actual or latent damage to the equipment should be identified in the system design documentation. This should include temperature, dust/moisture ingress, humidity and vibration.

Equipment should not be installed in a plant room (or similar location), unless the room is maintained in an acceptable state, including being free of dust from other trades.

NOTE Electronic equipment can fail due to dust-clogged heat sinks or fans.

6.4.5 SHEVs

Ventilators should be located as high as reasonably practicable within the roof and with a maximum spacing of 20 m. At least one ventilator should be provided for every 400 m² plan area of the smoke zone.

Roof ventilators should not be located:

- a) within 8 m of the perimeter of a smoke zone, unless intended for edge of zone slot ventilation; or
- b) in areas potentially subject to positive wind pressures (see Annex D).

6.4.6 Smoke barriers

Smoke barriers should be installed in accordance with BS EN 12101-1, ensuring they are located in positions not subject to wind or other significant variable air currents.

Active smoke barriers can deflect or bellow in use under pressure. Barriers and adjacent structure should therefore be arranged so that the deflection does not increase any edge gaps, unless the increased edge gaps can be accommodated within the overall smoke control system design.

6.4.7 Impulse fans

Any impulse fan should be located so that:

- a) the initial jet from the fan is not interrupted by:
 - 1) down stand beams;
 - 2) high-level services;
 - 3) columns or walls; and
- b) the risk of interruption by parked vehicles is minimized.

6.4.8 Inlet ventilators or grilles

Air inlets should be located and sized so that the inlet air velocity does not:

- a) risk fanning the flames;
- b) cause the smoke plume to lean or be otherwise disturbed;
- c) disturb the smoke layer boundary.

NOTE 1 This can normally be achieved by ensuring that the inlet air velocity does not exceed 1 m/s at any point where it can interact with the fire or smoke plume and that the top of the inlet is at least 1 m below the design smoke layer interface.

Air inlets should be sized so that the inlet velocity through any door opened for escape does not exceed 5 m/s.

NOTE 2 These restrictions do not apply in the case of a compartment fire at the boundary between the compartment and a large space (mall or atrium) into which smoke is spilled before being exhausted from the building.

Inlet air should be taken from locations unlikely to be affected by smoke.

6.4.9 Shaft systems

In addition to the recommendations/guidance given in BS 9999 and BS 9991 the following recommendations should be followed.

- a) Shafts should be located as close as possible to the space being ventilated. Where a natural shaft is used the shaft vent should open directly into the shaft or via a short straight stub duct. Where this is not possible the vent and connecting duct should be designed and sized to be no more resistive to flow than a shaft vent of the specified size alone.

NOTE The duct and vent need to be oversized to achieve this.

- b) The shaft vent should be located as high as possible within the ventilated space. The top should be no lower than the top of the door to the stair.
- c) Where the shaft system is being used to permit an extended travel distance for persons evacuating the building, the air inlet and smoke discharge should be as close to the opposite ends of the corridor as possible, and should in any case not leave more than 5 m between the vent and the furthest door beyond the vent. The direction of airflow should, as far as is practicable, move smoke away from the stair door.
- d) The stair vent and the termination of any smoke shaft should be located as far as practicable so that:
 - 1) they are not subjected to positive wind pressures;
 - 2) smoke does not re-enter the building through the stair vent.

6.4.10 Smoke control dampers

6.4.10.1 Single compartment

6.4.10.1.1 General

NOTE 1 Single compartment smoke control dampers have classifications at 600 °C. They are suitable for use at all temperatures below 600 °C.

Smoke control dampers should as a minimum be classified to BS EN 12101-8 as single compartment smoke control dampers (multi-compartment smoke control dampers are allowed in their place).

As they are for single compartment applications, any smoke control dampers should not be used to protect a fire compartment barrier. Sufficiently large openings should be allowed at any wall to permit the smoke control dampers to be installed if they are to be within the boundary. Alternatively, the dampers should be mounted in series with, or on the surface of, the single compartment smoke control duct.

NOTE 2 Further information is given in the ASFP Blue Book European version [5].

6.4.10.1.2 With automatic activation

If the system:

- a) automatically starts on the receipt of a fire or smoke alarm; and
- b) the smoke control dampers move immediately to their required position; and
- c) there is no override required at any point,

then single compartment smoke control dampers classified to BS EN 12101-8 as suitable for automatic activation should be used. If an override is required for smoke clearance, but only after the event, this should be allowed, but it should be noted that any dampers that are closed might remain closed as they have not been proven to open again after exposure to elevated temperatures.