Smoke control systems

How electrical contractors can help create safe and effective solutions

SELECT

Contents

Smoke Control Systems – General

It has been long recognised that most deaths from fire are caused by smoke inhalation. The contents of the products of combustion will vary depending upon what is burning, however carbon monoxide (CO) exposure accounts for most fire fatalities. For those seeking to escape from a building, smoke limits light distribution and hence visibility. This means that people escaping will have a greater likelihood of injury or death unless smoke is controlled.

A smoke control system controls the movement of smoke and air such that occupants are better able to safely evacuate from a building. There has been an increasing use of smoke control systems of one sort or another in the last decade. It is likely that, in the light of recent tragedies, the installation of smoke control systems will be one of the fire safety systems that will increase in popularity for new builds.

This leaflet briefly details certain types of smoke control system, the role of the electrical contractor in cooperating with the designer and other stakeholders to create a safe and effective system, and the relevant standards that should be considered when designing and installing the electrical systems.

Smoke Control Systems – *General (continued)*

Types of smoke control system

Section 10.4 of CIBSE Guide E details a variety of smoke control systems:

- Smoke dilution
- Opposed air flow
- Pressure differential
- Natural ventilation
- Mechanical ventilation.

Smoke dilution systems provide a means of smoke clearance. Smoke dilution systems typically rely on a flow of air between opposing vents on the same floor (cross-ventilation systems) (Fig. 1).

Opposed air flow systems control the movement of smoke by creating an air flow towards the fire, thus causing the smoke to be contained (Fig. 2).

Fig. 1 Smoke dilution system
In the event of a fire, the actuators open high level smoke vents and low level fresh air inlet vents

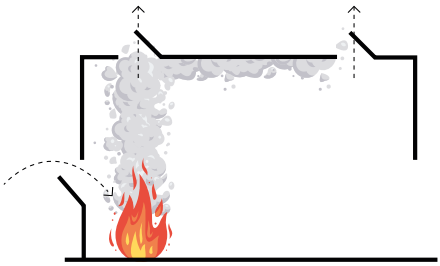
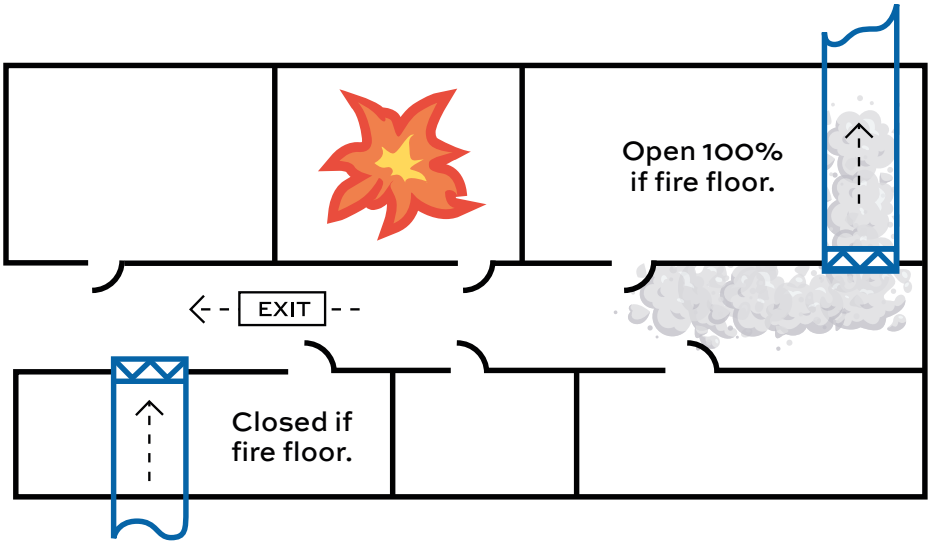


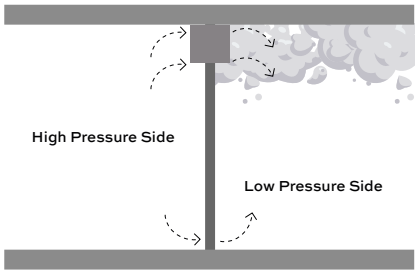
Fig.2 Opposed air flow
Systems create air flow towards the fire



Smoke Control Systems – *General (continued)*

Pressure differential systems either reduce the pressure in a space to allow for smoke to be extracted or increase the pressure of the surrounding area, reducing the chance of smoke escaping from a space (Fig. 3).

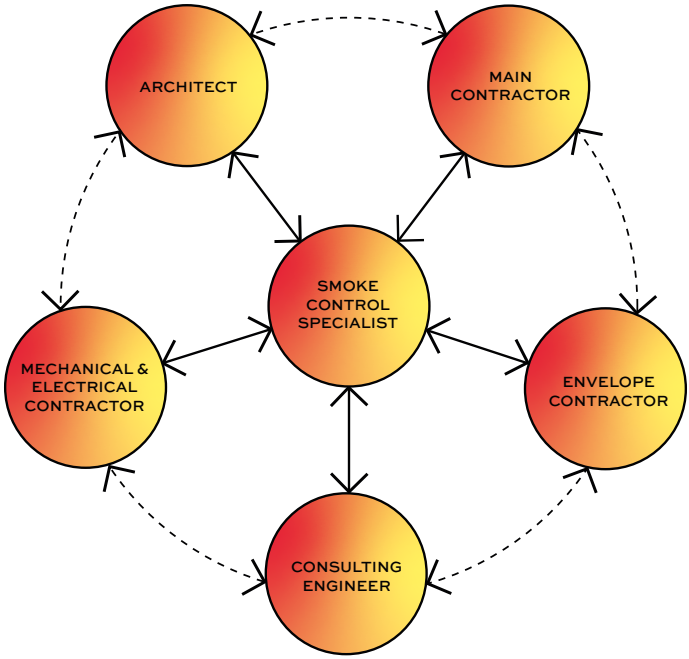
Fig.3 Pressure differential
System controls smoke by altering the pressure



Team approach to design

While the electrical contractor is a specialist in his/her field, it is essential that there is an integrated approach to the design of a smoke control system. The role of the smoke control specialist, along with the expertise of the consulting engineer, will be critical in the design of a suitable system (Fig. 4).

Fig.4 Team approach to design
The smoke control specialist has a critical role



Smoke Control Systems – *General (continued)*

Clause 4.2 of BS 7346-8: 2013 (detailed later in this leaflet) states: "Responsibility for the planning, design, installation and initial performance of the installed system should be clearly defined and documented." The electrical contractor must, therefore, make sure that they are part of the design process to ensure that all aspects of the electrical installation design are duly considered. While it is likely that a smoke control specialist will carry out the commissioning of the system, there will be a need for the electrical contractor to be involved in the completion of the Installation Certificate detailed in the informative Annex B of BS 7346-8.

Guides and standards

There is not one single standard or guide covering smoke control systems. All of the relevant guides and standards should be taken into account in the design and installation of the smoke control system.

All electrical installations should comply with the general and specific requirements of BS 7671.

CIBSE

CIBSE Guide E – Fire Safety Engineering, typically used by consulting engineers, gives guidance as to the types of system and the factors that should be considered by the designer.

Smoke Control Systems – *General (continued)*

Scottish Government's Building Standards Division Technical Handbooks

Every building must be designed and constructed in such a way that in the event of an outbreak of fire within the building, the occupants, once alerted to the outbreak of the fire, are provided with the opportunity to escape from the building before being affected by fire or smoke. *Building Standards Technical Handbook 2020: Domestic* references smoke ventilation in escape routes in clauses 2.9.14 – 2.9.16. Reference is also made to Table 2.4 Escape routes from flats and maisonettes and any ancillary rooms.

Building Standards Technical Handbook 2020: Non-Domestic recognises in 2.9 (Escape), that the first hazard to occupants beyond the room of fire origin will be from the products of combustion (clause 2.9.13 Fire and smoke control in corridors). Clause 2.9.13 recommends that where an escape route exceeds the dimensions detailed in the clause, one option would be to install a smoke control system.

BS 7346 series

Smoke clearance and control systems should be designed and installed in accordance with the recommendations of all parts of BS 7346 and the BS EN 12101 series without neglecting other relevant referenced standards such as, for example, BS 8519 and BS 7671.

BS EN 12101 series

The BS EN 12101 series gives guidance on smoke and heat control systems.

- Part 1: Specification for smoke barriers
- Part 2: Natural smoke and heat exhaust ventilators
- Part 3: Powered smoke and heat control ventilators (fans)
- Part 6: Specification for pressure differential systems
- Part 7: Smoke duct sections
- Part 8: Smoke control dampers
- Part 10: Power supplies.

Height of topmost storey of dwelling above, or basement depth below adjacent ground	Summary of recommendations
Basement storey at a depth not more than 4.5m (if applicable) and topmost storey not more than 7.5m	There are four possible options permitted, of which the first option includes smoke ventilation: At least one escape route and: ● Protected lobbies (2.9.13) ● Smoke ventilation (2.9.14–2.9.16) ● Not more than 10m travel distance inside protected lobby.
Topmost storey more than 7.5m but not more than 18m	There are two possible options permitted, of which the third option includes smoke ventilation: At least one escape route and: ● Protected lobbies (2.9.13) ● Smoke ventilation (2.9.14–2.9.16) ● Not more than 10m travel distance inside protected lobby.

The BS EN 12101 series is referenced in both the domestic and non-domestic *Building Standards Technical Handbooks*. Within the various parts, there are several factors that should be considered by the electrical contractor when either installing or maintaining smoke control systems. These will be addressed later in this leaflet.

BS 8519

BS 8519: 2020 Selection and installation of fire-resistant power and control cable systems for life safety, fire-fighting and other critical applications – Code of practice gives recommendations relevant to the installation of life safety systems and is referenced within BS 7346.

BS 7671

BS 7671 Requirements for Electrical Installations (IET Wiring Regulations) details the general and specific requirements for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations.

BS 9999

BS 9999: 2017 Fire safety in the design, management and use of buildings – Code of practice gives recommendations on heat and smoke control in non-residential buildings (clause 27).

BS 9991

BS 9991: 2015 Fire safety in the design, management and use of residential buildings – Code of practice gives recommendations on heat and smoke control in residential buildings (clause 14).

BS 5839–1

BS 5839-1 Fire detection and fire alarm systems for buildings Part 1: Code of practice for design, installation, commissioning, and maintenance in non-domestic premises gives recommendations on the links to be made between such systems and smoke control systems.

Conclusion

As can be seen, there are many standards that apply to the design, installation and commissioning of smoke control systems. The second part of this leaflet will cover these standards in more detail and highlight particular aspects as they relate to smoke control systems.

Smoke Control Systems – Application of Standards

This part of the leaflet will discuss specific recommendations of the various standards.

BS 7346 series

Smoke clearance and control systems should be designed and installed in accordance with the recommendations of all parts of BS 7346 and the BS EN 12101 series without neglecting other relevant referenced standards such as, for example, BS 8519 and BS 7671.

BS 7346–8: 2013 Components for smoke control systems Part 8: Code of practice for planning, design, installation, commissioning, and maintenance

Part 8 of the BS 7346 series covers the planning, design, installation, commissioning, and acceptance for components of smoke control systems. To that end, clause 6.8 covers locations for control equipment, clause 6.9 covers power supplies, clause 6.10 covers cables and clause 7 covers installation work.

The general requirements of BS 7671 apply to all electrical installation work. Smoke control equipment should be installed by competent persons in accordance with manufacturer's instructions and the technical specification. Ideally, the installer should be registered with an installation competence scheme, such as SELECT (clause 7.1).

Control equipment should be located in a clean, dry, permanently manned environment. There should be little risk of mechanical damage and low exposure to heat or fire. Furthermore, the location should be free from excess temperature, humidity, and dust (clause 6.8.1.1). The lighting levels should afford easy recognition of labels and visual indicators, and background noise levels should be such as to allow for audible signals to be heard (clause 6.8.1.3).

Smoke Control Systems –
Application of Standards (continued)

Where there are multiple access points for the fire and rescue services, repeat indicator panels should be installed, especially where the control equipment is not permanently manned (clause 6.8.2).

Power supply equipment should conform to the recommendations of BS EN 12101-10. The connection to the power supply should be from a suitably protected separate circuit, clearly labelled and identified as to its purpose, and independent of any other main or sub-main circuit. The circuit should be secured against any unauthorised operation (clause 6.9.2).

Where the power supplies for motors are derived from frequency inverters, there should be a fail-safe fire mode. This should disable the motor protection function and allow the inverter/motor to run to destruction (clause 6.9.4).

Where a standby generator is necessary to maintain essential safety services, it should be sized to maintain the maximum system design load. Furthermore, it should be capable of providing the essential life safety and fire-fighting loads within 15 seconds of the loss of primary power (clause 6.9.5).

The cables used in smoke control systems need to maintain the circuit under fire conditions. Clause 7.2.2 of BS 7346-8, as with clause 26.2 f of BS 5839-1, recommends that the resistance to fire of the cable fixings, cable containment systems and any joints installed are at least equivalent to the survival times of the cables. The minimum recommended cable survival time should be 120 minutes (clause 6.10.1) as recommended in Table 1 of BS 8519. Cables that will comply with this

Fig.5 Model certificate of installation
Appropriate documentation must be issued after installing a smoke control system

recommendation include MI and any rated PH120 or F120, such as enhanced fire resistant steel wire armoured (SWA) cable, Firetuf (trade name) and the like.

Any cable support system, such as support brackets, drops and hangers, should have a fire survival time equivalent to that of the cables for the defined fire conditions (clause 7.2.3).

In addition to the need to issue an appropriate Electrical Installation Certificate, it is also necessary for the electrical contractor to issue a certificate of installation of the smoke control system based on the model certificate (Fig. 5) in Annex B.2 of BS 7346-8 (clause 8.3).

Smoke Control Systems – *Application of Standards (continued)*

BS 7346–7: 2013 Components for smoke control systems Part 7: Code of practice on functional recommendations and calculation methods for smoke and heat control systems for covered car parks

Many of the recommendations in Part 7 of BS 7346 are similar to those found in Part 8 of BS 7346.

Part 7 of BS 7346 is specific to covered car parks and is designed to enable firefighters to have relatively smoke free access to a point close to the seat of fire. To initiate the smoke control system of the car park, one or more of the following should act as a trigger:

- Smoke detection
- Rapid rate of rise heat detection
- Multi-criteria detection (clause 10.1.15).

It is also necessary for the fire and rescue service to have an override switch.

There should be clear and early discussions between the designer of the smoke control system and the designer of the fire detection and fire alarm system to ensure that each organisation's roles and responsibilities are clearly defined. The installer of either of the systems should be clear where the limits of their responsibilities lie. (Reference BS 5839-1:2017 clause 6.2f).

To enable power supplies to be maintained for the required time, clause 14 of Part 7 recommends that the necessary power supplies be suitably rated; it should be capable of supplying the necessary load as well as being protected from the effects of fire and/or water for the necessary period of time. To this end, the power supplies should conform to the recommendations of BS EN 12101-10.

Life safety and fire-fighting systems should have a dual supply (clause 14.4.1.3). The primary and secondary supplies should be protected against both fire and water and installed separately from one another; that is, they should follow different routes. However, where the diverse routes come together in the same area, they should be separated from each other by a partition having a fire resistance of at least 60 minutes (clause 14.4.2). There are a range of materials that meet the 60 minute recommendation and many of these may be found at **www.british-gypsum.com/literature/white-book**

Distribution boards and the like should be separated from the remainder of the building by an enclosure providing 60 minutes of protection from the effects of fire and water damage (clause 14.4.3).

Installed cables should meet the requirements of BS 8519 for fire resistance. Table 1 of BS 8519 recommends the installation of category 3 cables (120-minute fire survival time, clause 14.4.6, see video at **bit.ly/TT-cable)**. It is also necessary for installed cables to maintain system integrity under fire conditions. For this reason, cable fixings, cable containment systems and joints (although these should be avoided, clause 14.4.7) should have the same fire survival time as the cable (clauses 14.4.7 and 14.4.8). Wherever possible, cables should be installed in such a way as to avoid car park spaces (clause 14.4.10) as this is considered to be an area of special risk.

Smoke Control Systems –
Application of Standards (continued)

Where the power supplies for motors are derived from frequency inverters, there should be a fail-safe fire mode. This should disable the motor protection function and allow the inverter/motor to run to destruction (clause 14.4.9).

BS EN 12101 Smoke and heat control system

The BS EN 12101 series, particularly Part 3 and Part 10, is referenced in both the domestic and non-domestic *Building Standards Technical Handbooks*, as well as a series of standards, including BS 7346 and BS 8519.

Within the various parts of BS EN 12101 there are several factors that should be considered by the electrical contractor when either installing or maintaining smoke control systems.

Part 3

In Annex G of BS EN 12101-3 it is recommended that the manufacturer provides appropriate maintenance information for powered smoke and heat control ventilators to include:

- Inspection and maintenance procedures
- Frequency of operational checks.

Where the electrical contractor is involved in maintenance, reference should be made to manufacturer's instructions.

Part 10

BS EN 12101-10 details the recommendations for power supplies for smoke and heat control systems.

Power supplies should operate from the public electricity supply. Where there is a failure of normal power, a smoke and heat control system that fails to the fire operational position need not have a secondary power source. Fig. 6 provides examples showing typical locations and interrelationships of electrical power supply equipment with other components of smoke control systems.

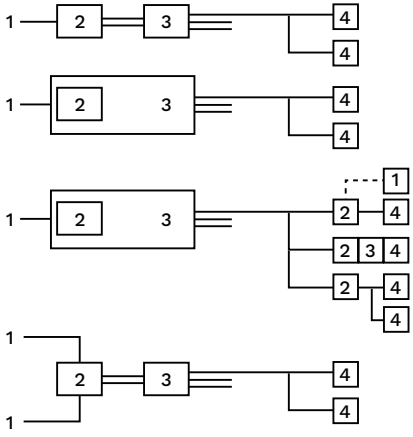


Fig. 6 Interrelationships of electrical power supply equipment
Some examples of typical locations

For non-fail safe systems, a secondary power source is necessary; this power source may be, for example, a battery or motor-generator. The secondary supply must be permanently available, tested and maintained (clause 4.1). If the primary power supply fails, the supply

must be automatically switched to the secondary source. When the primary power source is re-energised, the supply should be automatically switched back.

Where there is an interruption in switching from one source to the other and vice-versa, the duration of the interruption shall meet the maximum interruption time detailed by the manufacturer (clause 9.1).

The system should be designed and installed such that the failure of one power source shall not cause the loss of any other power source or the supply to the system (clause 4). To this end, it will also be relevant to consider clause 7 of BS 8519 when designing diverse cable routes and clause 6 of BS 8519 when considering power supplies.

It is permissible for the secondary power supply to be used for other functions, such as day to day comfort ventilation. However, if it is used in such a way, sufficient power must be retained for emergency use (clause 6).

Where a battery is used as the secondary power supply, it must be capable of continuously supplying the maximum standby current (clause 6.1). At the end of the maximum standby period, the battery must be capable of supplying the maximum short duration current for 180 seconds (clause 6.2). To allow for possible failure of equipment or primary power supply failure, the battery should be capable of maintaining the system in operation for at least 72 hours, unless there is immediate notification of the failure either by local or remote supervision (clause 6.2 Note 1).

Conclusion

Electrical contractors installing electrical installations associated with smoke control systems should become familiar with the range of standards that apply to the smoke control systems. It is clear that, post–Grenfell, the requirement for competence is a key issue for all people involved with the construction industry.

Indeed, in response to the Hackitt review, the Smoke Control Association has launched a certification scheme for contractors involved in smoke control systems. The scheme has been developed to deliver competency in fire strategy verification, system design and the installation of smoke control systems. While the electrical contractor may not need to register with such a scheme, the contractor should ensure that they are part of the design process at the earliest opportunity to ensure that any electrical installation issues are addressed early in the design process.

Founded in 1900, SELECT is Scotland's largest construction trade association.

It has nearly 1,250 member businesses who collectively have an annual turnover of around £1billion and employ over 15,000 people and 3,500 apprentices.

SELECT also delivers training courses to more than 3,500 electricians each year and is committed to regulation of the industry for a safer Scotland.

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