BRITISH STANDARD

BS 5588-9:1999

Incorporating Amendment No. 1

Fire precautions in the design, construction and use of buildings —

Part 9: Code of practice for ventilation and air conditioning ductwork

ICS 13.220.01; 91.140.30

British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee FSH/25, Smoke and heat control systems and components, upon which the following bodies were represented:

Association of Roof Light Manufacturers
British Blind and Shutter Association
Chartered Institute of Building Services Engineers
Consumer Policy Committee of BSI
Department of Health (NHS Estates)
Department of the Environment, Transport and The Regions
District Surveyors Association
Fire Resistant Glass and Glazed Systems
HEVAC Association
Home Office
International Fire Consultants Ltd.
London Fire and Civil Defence Authority
Loss Prevention Council
Steel Window Association
Warrington Fire Research Centre
Co-opted members

This British Standard, having been prepared under the direction of the Health and Environment Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 September 1999

The following BSI references relate to the work on this British Standard:
Committee reference FSH/25
Draft for comment 98/542695 DC

ISBN 0 580 33041 9

Amendments issued since publication

Amd. No.	Date	Comments
14993	8 December 2004	See national foreword

Contents

Foreword

This part of BS 5588 was prepared by Technical Committee FSH/25.
It supersedes BS 5588-9:1989 which is withdrawn.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1⟩ ⟨A1. Tags indicating changes to text carry the number of the amendment. For example, text altered by Amendment No. 1 is indicated by A1⟩ ⟨A1.

All matters dealing with fire safety management are now located in BS 5588-12.

Other parts which comprise BS 5588 are as follows:

— *Part 0: Guide to fire safety codes of practice for particular premises/applications*;

— *Part 1: Code of practice for residential buildings*;

— *Part 4: Code of practice for smoke control using pressure differentials*;

— *Part 5: Code of practice for firefighting stairs and lifts*;

— *Part 6: Code of practice for places of assembly*;

— *Part 7: Code of practice for the incorporation of atria in buildings*;

— *Part 8: Code of practice for means of escape for disabled people*;

— *Part 10: Code of practice for shopping complexes*;

— *Part 11: Code of practice for shops, offices, industrial, storage and other similar buildings*;

— *Part 12: Managing fire safety.*

Some of the more important changes introduced in this revision of this part of BS 5588 are as follows.

a) Intumescent dampers are now included.

b) Alternative solutions are given to smoke detector control of fire/smoke dampers in hotels.

c) Provision of smoke detector operated fire/smoke dampers in places of entertainment, hospitals and premises with a sleeping risk is now included.

d) Changes have been made to the three methods of protecting ductwork.

e) Recommendations are given for ductwork passing through escape routes.

f) Recommendations have been added for the following:

1) fire dampers;

2) the installation of ductwork systems;

3) fan rooms;

4) transfer grilles;

5) air handling voids;

6) recirculating distribution systems;

7) firefighting controls; and

8) domestic heating, ventilation and air conditioning (HVAC) systems.

It has been assumed in the drafting of this standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people.

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.

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 does not of itself confer immunity from legal obligations.

In particular, attention is drawn to **4.4**.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 29 and a back cover.

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

Introduction

The fire protection of ventilation systems has, in the past, tended to be considered primarily in the context of the breakdown of fire compartmentation in buildings.

Ventilation systems and ductwork however can be responsible for accelerating the initial spread of fire, for example between rooms within a fire compartment, and, perhaps of even more importance, by the rapid dispersion of smoke and decomposition products. This part of BS 5588 therefore considers the system as a whole and recommends the protection that needs to be provided in order to meet the specific requirements of any given type of building or occupancy.

This standard draws attention to the potential fire dangers associated with ventilation and air conditioning ductwork. The systems covered include ducted supply and extract systems, whether through ducts or plenums, mechanically assisted systems and those relying on natural convection. It discusses a range of protective measures, the adoption of which should effectively counterbalance the potential dangers of fire. It offers guidance on the appropriateness of such protective methods in a range of circumstances. However, no single recommendation is made in respect of any specific method of protection for a given type of occupancy. Each project needs to be examined by the designer to identify the potential dangers before selecting the appropriate protective measures.

A fire can generate large quantities of combustion products (usually referred to as “smoke”), namely hot gases carrying smoke particles and containing toxic or noxious and irritant products.

The standard is mainly concerned with providing advice on the selection of appropriate measures for the effective isolation of the ventilation system, that will confine fire, smoke and decomposition products within a pre-selected area of the building, or within the system itself, in such a way that other areas are subject neither to fire attack nor to the spread of smoke and/or toxic gases.

In the event of a fire within a building, ventilation by natural or mechanical means can be used to limit the spread of these products which could otherwise hinder or prevent escape and thus endanger the lives of the occupants, and restrict or prevent effective rescue and firefighting by the fire brigade. The requirements for ventilation in the event of fire may, on occasion, be incompatible with those for normal ventilation. In most cases larger flows of air or gases have to be allowed for, in directions sometimes different from those required for normal ventilation.

Experimental evidence of the efficacy of measures to prevent fire spread by way of ductwork is scarce. A considerable international effort is being made, aimed at a better understanding of the problems of fire and smoke spread associated with ventilation ductwork. In particular this concerns the pressure distribution throughout a building and how this is affected, either directly or indirectly, by fire. This standard is based on the best available information in respect of both practical experience and scientific investigation.

Throughout the standard, life safety is the primary consideration underlying the recommendations. However, the standard also covers matters which are relevant to the protection of the building and its contents from fire as well as to the safety of the occupants.

1 Scope

This part of BS 5588 provides guidance for designers and the building construction team on the incorporation of ventilation and air conditioning ductwork into new and existing buildings other than premises covered by BS 5908.

NOTE 1 It is essential that the recommendations given in this part of BS 5588 are applied anew if physical alterations are made to an existing building which have a detrimental effect on the means of escape from the building, even if such alterations are not structural.

The standard covers non-combustible building service ducts, and ductwork manufactured from metal and/or rigid mineral based components which exhibit:

a) high integrity when exposed to fully developed fire conditions;

b) resistance to penetration by flame;

c) an ability to exclude or contain fire.

It does not cover ductwork manufactured from materials that rapidly melt, shatter or degrade during fire exposure, for example glass and plastics materials.

The standard covers precautions to prevent the spread of fire and smoke and other by-products of combustion within a building through the movement of air for environmental control, i.e. ventilation, heating and cooling. It does not cover the movement of air for purposes other than for environmental control, e.g. boiler flues, pneumatic information transfer systems, nor smoke control systems, pressure differential systems and industrial process plant extract systems.

NOTE 2 The design and construction of service ducts is covered in BS 8313, the design of pressurization systems for smoke control in protected escape routes is covered in BS 5588-4, and the design of smoke control systems within atria buildings, places of assembly and shopping complexes are covered in BS 5588-6, -7 and -10 respectively.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 476-4, *Fire tests on building materials and structures — Part 4: Non-combustibility test for materials.*

BS 476-6:1989, *Fire tests on building materials and structures — Part 6: Method of test for fire propagation for products.*

BS 476-7:1997, *Fire tests on building materials and structures — Part 7: Method for classification of the surface spread of flame of products.*

BS 476-8, *Fire tests on building materials and structures — Part 8: Test methods and criteria for the fire resistance of elements of building construction.*

BS 476-11, *Fire tests on building materials and structures — Part 11: Method for assessing the heat emission from building materials.*

BS 476-20, *Fire tests on building materials and structures — Part 20: Method for determination of the fire resistance of elements of construction (general principles).*

BS 476-21, *Fire tests on building materials and structures — Part 21: Method for determination of the fire resistance of loadbearing elements of construction.*

BS 476-22, *Fire tests on building materials and structures — Part 22: Method for determination of the fire resistance of non-loadbearing elements of construction.*

BS 476-23, *Fire tests on building materials and structures — Part 23: Methods of determination of the contribution of components to the fire resistance of a structure.*

BS 476-24, *Fire tests on building materials and structures — Part 24: Method for determination of the fire resistance of ventilation ducts.*

BS 5445-7, *Components of automatic fire detection systems — Part 7: Specification for point-type smoke detectors using scattered light, transmitted light or ionization.*

BS 5499-1, *Fire safety signs, notices and graphic symbols — Part 1: Specification for fire safety signs.*

BS 5588-1:1990, *Fire precautions in the design,* [A1⟩ *construction and use* ⟨A1] *of buildings — Part 1: Code of practice for residential buildings.*

[A1⟩ BS 5588-12, *Fire precautions in the design, construction and use of buildings — Part 12: Managing fire safety.* ⟨A1]

[A1⟩ *Text deleted* ⟨A1]

BS 5839-1:1988, *Fire detection and alarm systems for buildings — Part 1: Code of practice for system design, installation and servicing.*

BS 5839-3, *Fire detection and alarm systems for buildings — Part 3: Specification for automatic release mechanisms for certain fire protection equipment.*

BS 8313, *Code of practice for accommodation of building services in ducts.*

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

3 Definitions

For the purposes of this part of BS 5588 the following definitions apply.

3.1
air handling void
duct which forms part of either the supply or the return air distribution system

NOTE 1 This is usually a ceiling or floor void.

NOTE 2 Also known as a "plenum".

3.2
cavity barrier
construction provided either:

a) to seal a cavity (concealed space) against the penetration of smoke and flame; or

b) within a cavity (concealed space) to restrict the movement of smoke and flame within the cavity

3.3
ceiling void
cavity between a structural floor or roof and the suspended ceiling below, through which building services may pass

3.4
class 0 surface
surface which is either:

a) composed throughout of materials of limited combustibility; or

b) composed of a material classified as class 1 when tested in accordance with BS 476-7:1997, which has a fire propagation index I of not more than 12, and a sub-index i_1 of not more than 6, when tested in accordance with BS 476-6:1989

3.5
duct
passage inside which services are led through a building

NOTE Examples of services are water pipes, electrical cables and air ductwork.

3.6
ductwork
system of enclosures for the distribution or extraction of air

NOTE The enclosures can be of any cross-sectional shape.

3.7
fire compartment
building or part of a building, comprising one or more rooms, spaces or storeys, constructed to prevent the spread of fire to or from another part of the same building, or an adjoining building

NOTE Also referred to in this standard as a "compartment".

3.8
fire damper
mobile closure or intumescent device within a duct which is operated automatically and is designed to prevent the passage of fire and which, together with its frame, is capable of satisfying for a stated period of time the same fire resistance criterion for integrity as the element of the building construction through which the duct passes

3.9
fire/smoke damper
combined fire and smoke damper

NOTE See **3.8** fire damper, and **3.20** smoke damper.

3.10
fire resistance
ability of a component or construction of a building to conform for a stated period of time to the appropriate criteria specified in the relevant part of BS 476

3.11
fire stopping
process for sealing or closing an imperfection of fit between elements, components or construction of a building, or any joint, so as to restrict penetration of smoke and flame through that imperfection or joint

3.12
floor void
cavity between a structural floor and a platform floor above, through which building services may pass

3.13
material of limited combustibility
material which either:

a) is non-combustible; or

b) is of density 300 kg/m^3 or more and which, when tested in accordance with BS 476-11, does not flame and does not give a rise in temperature measured on the furnace thermocouple of more than 20 °C; or

c) has a non-combustible core of 8 mm thickness or more, with combustible facings (on one or both sides) not more than 0.5 mm thick

3.14
non-combustible material
material which conforms to the performance requirements specified in BS 476-4, or which, when tested in accordance with BS 476-11, does not flame and does not cause any rise in temperature on either the centre (specimen) or furnace thermocouples

3.15
pressurization
method of smoke control using pressure differentials, where the air pressure in the spaces being protected is raised above that in the fire zone

3.16
protected shaft
shaft of fire-resisting construction which enables persons, things or air to pass from one compartment to another

NOTE This can be, for example, a stairway, lift, escalator, chute or duct.

3.17
protected stairway, lobby or corridor
stairway, including any exit passageway leading therefrom to its final exit, lobby or corridor, separated from any other part of the building by fire-resisting construction

3.18
return air grille
grille connected to the ductwork system through which air is extracted from a room or space

3.19
shunt system
system in which branch ductwork, instead of making a direct connection to the main ductwork, turns through an angle and runs parallel to the main ductwork for a specified distance before turning into and connecting with the main ductwork

3.20
smoke damper
mechanical device which, when closed, prevents smoke passing through an aperture within a duct or structure

NOTE The device may be open or closed in its normal position and may be automatically or manually actuated.

3.21
supply grille
grille connected to the ductwork system through which air is discharged into a room or space

NOTE The term "supply grille" includes air diffusers.

3.22
thermally actuated device
device which releases a fire damper closing mechanism when the temperature in the vicinity of the fire damper rises to a predetermined value

3.23
transfer grille
fixed grille not connected to the ductwork system providing for the free transfer of air between adjacent rooms and/or spaces

4 Use of this standard

4.1 Means of providing for safety

The recommendations in this standard are intended to provide safety from fire by means of the following:

a) design and construction of ductwork systems to prevent their becoming the means by which fire, smoke and other products of combustion can spread from one compartment to another, or prejudice the safe use of escape routes;

b) construction and finishing with suitable materials to limit the spread of fire over or within the ductwork.

4.2 Use of the principles and recommendations

The fire hazard of a particular building and its contents has to be appreciated when designing a ductwork system. However, it is not possible to make comprehensive recommendations capable of covering every possible risk, and intelligent appraisal of the principles and application of the recommendations given in this standard are therefore essential.

4.3 Application of all the relevant recommendations

Individual recommendations given in this standard should not be applied in isolation. In order to ensure that a ductwork system is in accordance with this standard all the relevant recommendations need to be applied.

4.4 Relationship with statutory provisions

4.4.1 *General*

It is important to appreciate the relationships between this code and the various statutory provisions relevant to the design and construction of new buildings and to the fire precautions to be provided in existing buildings. The relevant legislation listed in **4.4.2** and **4.4.3** has to be complied with in the event of a conflict with this standard. However, there are two main ways in which this part of BS 5588 is intended to supplement the legislation.

The first is that, since Acts of Parliament and Regulations made under them are necessarily drafted in broad terms and cannot deal in detail with a wide variety of different situations, one of the objects of this standard is to provide guidance for the building designer in matters not covered in sufficient detail by the legislation. Secondly, because the objectives of the legislation are mainly concerned with the health and safety of the general public, this standard has a wider scope and includes matters relevant to the protection of the building and its contents from fire as well as to the safety of the occupants.

4.4.2 ***Building regulations***

The design and construction of new buildings, and of alterations of existing buildings, are controlled by the following statutory provisions.

England and Wales:	The Building Regulations
Scotland:	The Building Standards (Scotland) Regulations
Northern Ireland:	The Building Regulations (Northern Ireland)

It should be noted that some county and other authorities in England and Wales have local powers in respect of fire precautions.

4.4.3 ***Legislation and other regulations covering fire safety in existing premises***

In addition to the controls mentioned in **4.4.2**, fire safety and means of escape for a wide variety of buildings are dealt with under the following legislation.

England and Wales:

- The Fire Precautions Act, 1971, as amended by the Health and Safety at Work etc. Act, 1974.
- The Fire Safety and Safety of Places of Sport Act, 1987.
- The Building Act, 1984.
- The Fire Precautions (Workplace) Regulations, 1997.

Scotland:

- The Fire Precautions Act, 1971, as amended by the Health and Safety at Work etc. Act, 1974.
- The Fire Safety and Safety of Places of Sport Act, 1987.
- The Building (Scotland) Act, 1959 (as amended).
- The Fire Certificates (Special Premises) Regulations, 1976, SI 1976 No. 2003 (as amended).
- The Fire Precautions (Workplace) Regulations, 1997.

Northern Ireland:

- The Fire Services (Northern Ireland) Order, 1984.
- The Health and Safety at Work (Northern Ireland) Order, 1978.
- The Planning and Building Regulations (Amendment Order) (Northern Ireland) Order, 1990.
- The Fire Precautions (Workplace) Regulations (Northern Ireland), 1998.

There are also a number of local Acts as well as entertainment and other licensing legislation which deal with fire safety and means of escape. The designer should consult the fire authority and building authority at an early stage to make certain that the buildings as planned will meet the requirements those authorities may make, particularly if a fire certificate or licence may be necessary.

4.5 Information to be given to clients

Designers are advised to inform their clients of the nature and function of the fire precautions that have been designed into the ductwork system, and especially those the nature of which may be less evident. This will give the client a better understanding of his responsibilities for ensuring that a high standard of safety is maintained. Sufficient drawings and written information should also be given to the client on completion of the work to enable him to establish proper maintenance records [A1⟩ (see BS 5588-12) ⟨A1].

The advice given in [A1⟩ BS 5588-12 ⟨A1] is intended as a guide for the building management, and designers are advised to pass this on to their clients.

4.6 Diagrams

The figures are intended to clarify concepts, and should not be taken as indicating the only acceptable forms of planning or construction.

5 Analysis of the problem

5.1 General

A prerequisite of good structural fire precautions in most buildings is their division into compartments designed to prevent a fire in one from spreading to others. Each perforation of the compartment enclosure, be it a door, an opening in the floor for a stairway, or a duct, is a potential weakness in the fire design of the building and the appropriate precautions need to be taken to protect the integrity of the compartment.

Building service ducts are usually present throughout the whole of a building, passing from compartment to compartment, and should be fire-stopped whenever they penetrate fire-resisting walls, floors and ceilings.

However, the dangers posed by the perforation of fire compartment enclosures are exacerbated in the case of mechanical ventilation and air conditioning systems by, firstly, the size of both the ductwork and the holes needed for it to go through and, secondly, the need for ventilation ductwork, by design, to ensure the efficient circulation of air throughout the system. Thus, penetration of the system by hot gases, smoke and toxic decomposition products can result in extremely rapid spread of fire and smoke to any other area of the building unless suitable preventative measures are taken.

The fire prevention measures needed will vary according to the type of system, the design of the building and the necessity for rapid confinement of a localized fire. Thus, the selection of the method is largely dependent upon the individual requirements of a particular building and its occupancy. Generally, fire prevention measures are designed to:

a) prevent a fire from entering or leaving the ductwork;

b) limit the spread of fire, smoke and other products of combustion within the ductwork;

c) prevent a breach in the integrity of an enclosing fire-resisting element of construction where penetrated by ductwork.

The measures can be achieved by a combination of fire dampers, fire-resisting ductwork, fire-resisting enclosure of ductwork and adequate fire-stopping.

The spread of smoke and other products of combustion provides a more complex problem than the spread of fire. The extent of the dilution of the smoke and gases is dependent on the degree of mixing and thus on the design of the system and the point at which the smoke and gases enter it.

5.2 Fire problems of ventilation systems

5.2.1 *Smoke spread*

5.2.1.1 *General*

The rapidity and extent of the transmission of smoke through the ventilation system to remote parts of a building are of primary importance to life safety, particularly as the smoke is likely to contain toxic and/or noxious products of combustion. The areas contaminated will be determined by the comparative pressure conditions in parts of the building served by the system. These are affected by the following factors:

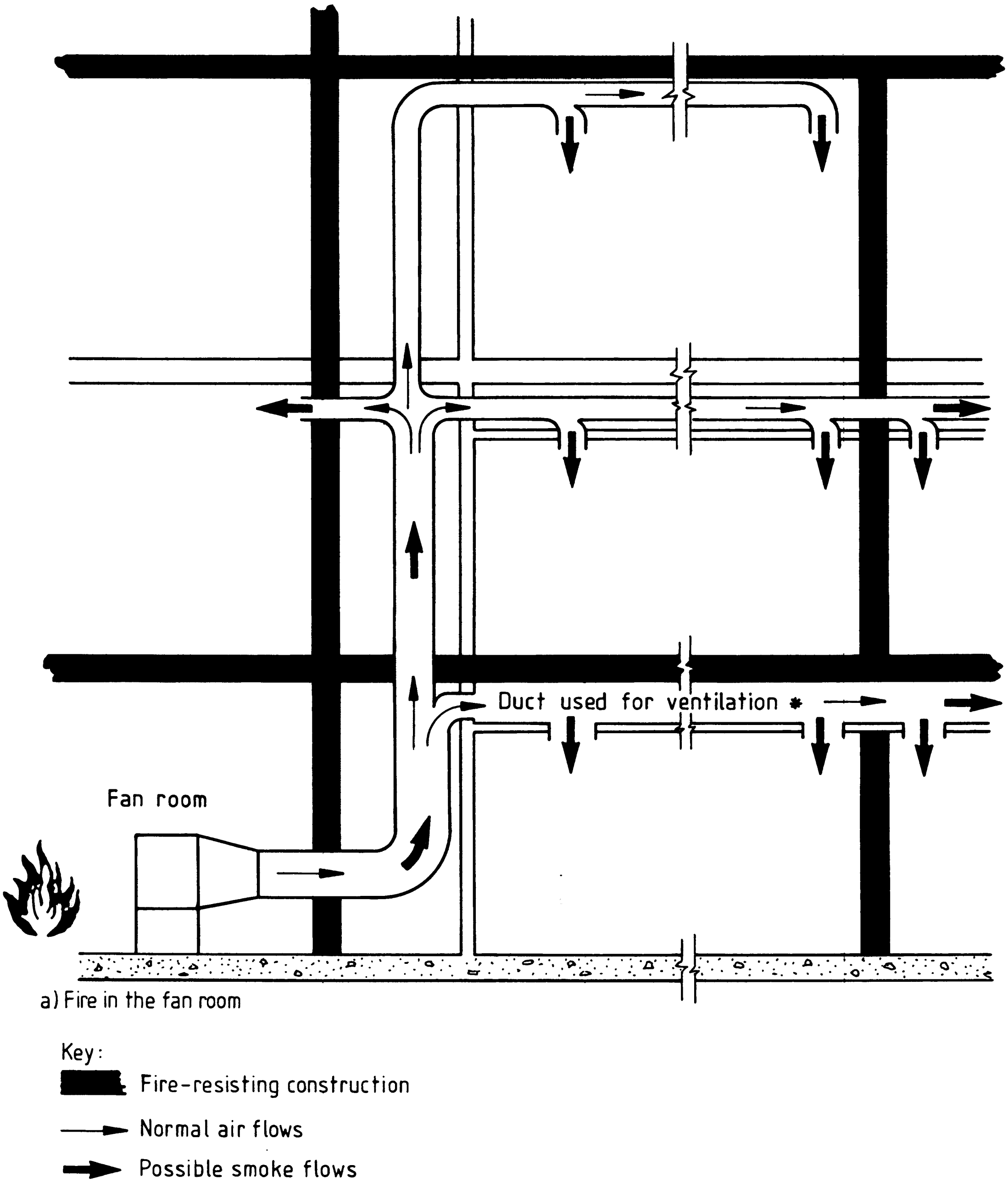
a) expansion effects due to the fire;

b) buoyancy effects due primarily to the fire (particularly in vertical ductwork);

c) wind effects on the building;

d) stack effects, i.e. effects caused by the differences between the indoor and outdoor temperatures.

The major potential problems of smoke spread within ventilation systems are illustrated in Figure 1.

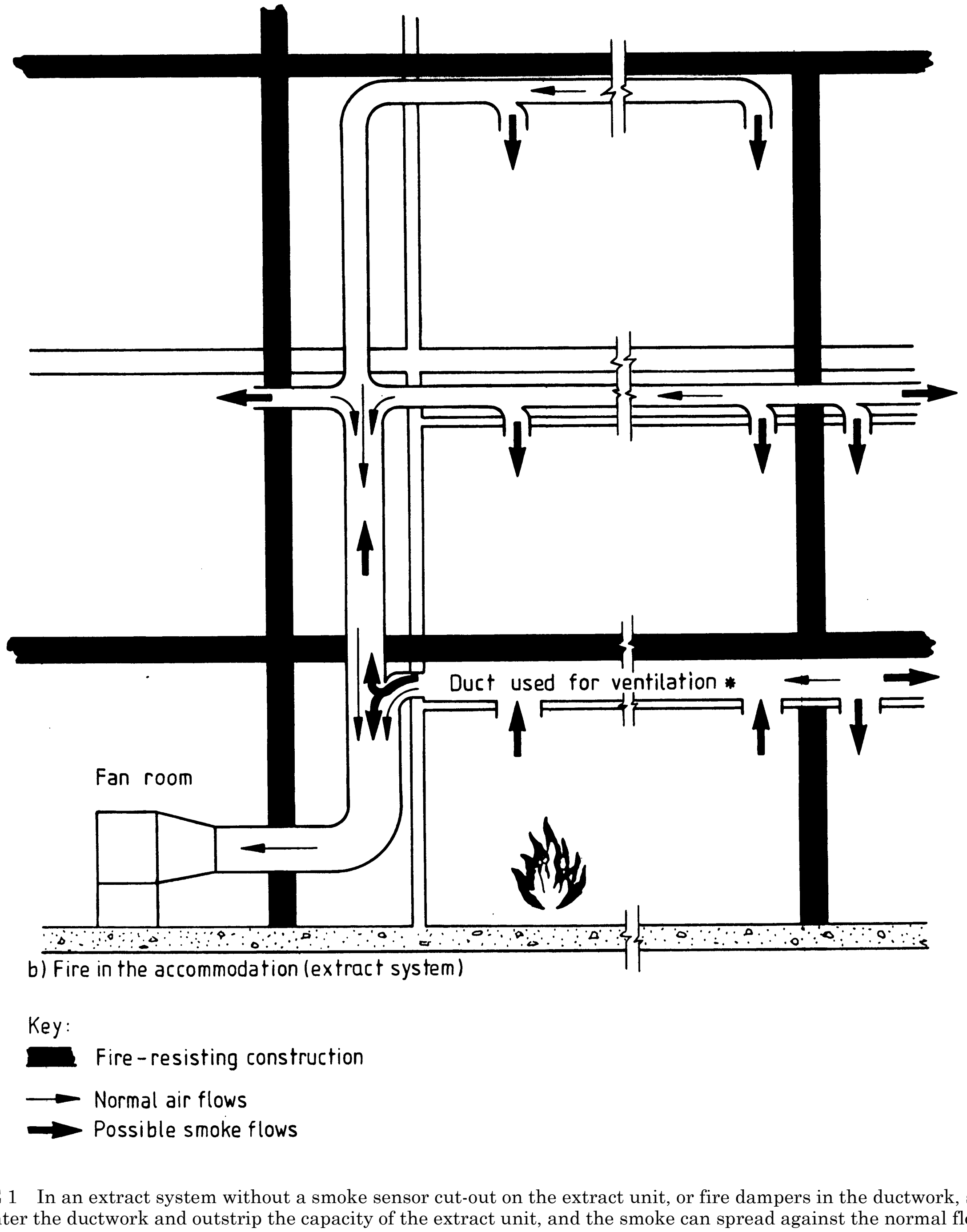


NOTE 1 In a supply system a fire in the fan room (or near to the supply inlet) could result in heat and smoke being circulated via ductwork throughout the building.

NOTE 2 In a system protected only by thermally actuated fire dampers there is a risk that a substantial amount of smoke will be circulated before the thermally actuated devices operate.

* Although not shown, cavity barriers may be required.

Figure 1 — Potential smoke spread within ventilation systems

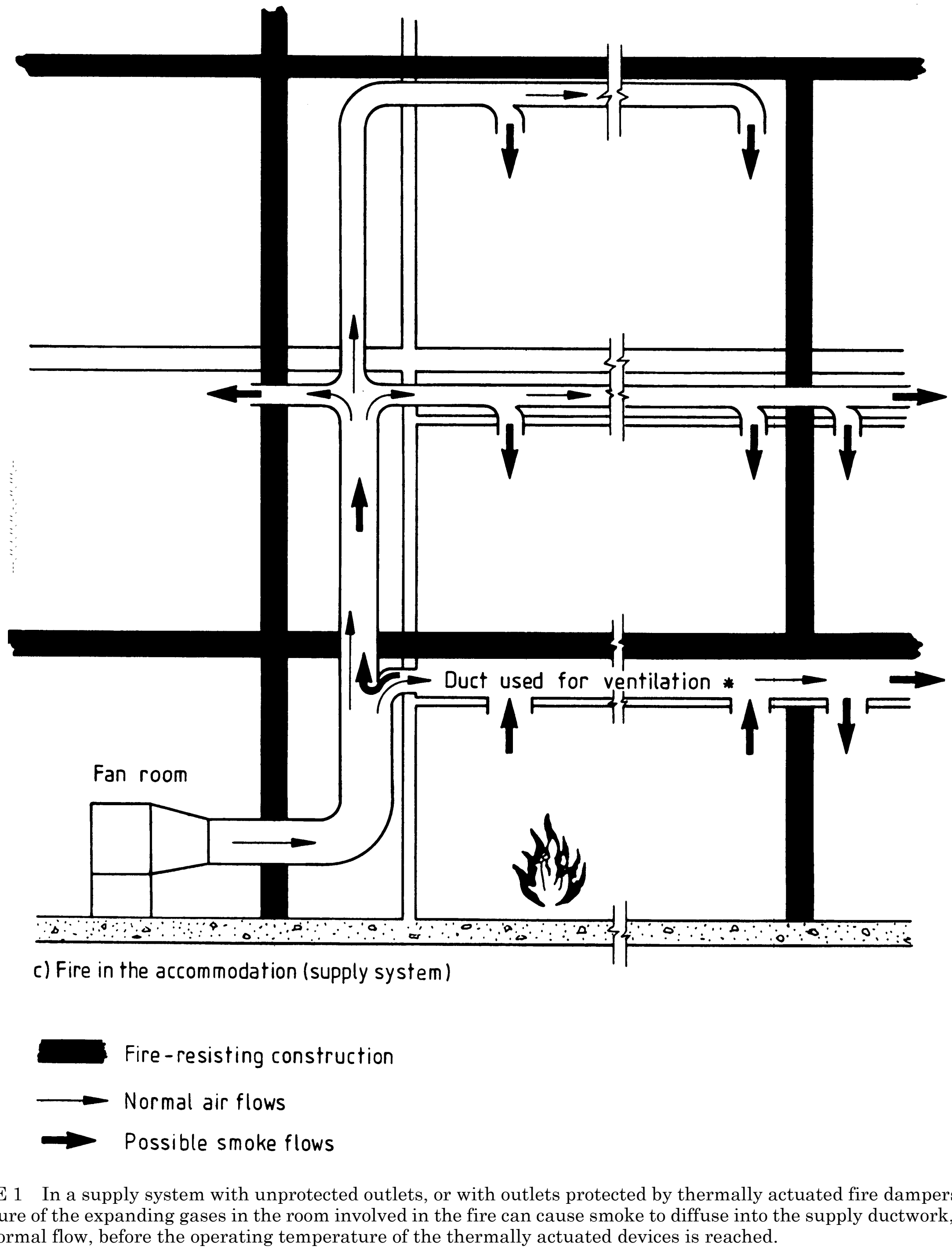


NOTE 1 In an extract system without a smoke sensor cut-out on the extract unit, or fire dampers in the ductwork, smoke can enter the ductwork and outstrip the capacity of the extract unit, and the smoke can spread against the normal flow into areas not immediately affected by the fire.

NOTE 2 Ductwork generally provides a path for the spread of smoke throughout the building.

* Although not shown, cavity barriers may be required.

Figure 1 — Potential smoke spread within ventilation systems (*continued*)



NOTE 1 In a supply system with unprotected outlets, or with outlets protected by thermally actuated fire dampers, the pressure of the expanding gases in the room involved in the fire can cause smoke to diffuse into the supply ductwork, against the normal flow, before the operating temperature of the thermally actuated devices is reached.

NOTE 2 Smoke could be carried into areas not affected by the fire and, with an unprotected system, hot gases and smoke could travel against a forced supply.

NOTE 3 Ductwork generally provides a path for the spread of smoke throughout the building.

* Although not shown, cavity barriers may be required.

Figure 1 — Potential smoke spread within ventilation systems (*continued*)

There is a potential for cool smoke and gases to spread through the system as long as the air handling plant continues to function and before fire dampers operate to isolate the fire area. Fire dampers, which are designed primarily to stop flames and hot gases passing from one area to another through the ductwork, are usually controlled by thermally actuated devices. Unless also actuated by smoke detectors, fire dampers will not close until the thermally actuated devices reach their operating temperature, and during this intervening period cool smoke may be drawn, or may diffuse, into the system and be circulated to other areas as yet unaffected by fire. Careful control of the extract plant during this period can assist the removal of such smoke.

Hot smoke and gases can spread against forced airflow in horizontal ductwork, and even more readily upwards in vertical ductwork, where expansion and buoyancy effects are sufficient to overcome the air velocity. However, dampers can be closed and the fan cut off early in this phase of fire development. In isolated compartments after the operation of the fire dampers, in systems without fan assistance or in others after automatic or manual cut-off or failure of the fan, smoke spread through the unobstructed ductwork will be primarily governed by differential pressures in the areas serviced by the system.

Voids between structural floors and suspended ceilings and between structural floors and platform floors are frequently used for air handling, i.e. the supply or extraction of air. Such voids frequently contain combustible materials, for example PVC sheathing to electrical and communications cabling and insulation applied externally to ductwork, and in such cases there is a risk of ignition of such materials by flames or hot gases being drawn across or introduced into the voids, thus adding to the potential for the spread of fire into the main mechanical ventilation system or to the spread of fire beneath occupied floors.

5.2.1.2 *Spread of smoke through the extract system*

The spread of fire gases into and through the system is immediate unless the extract system is situated near floor level. Cool smoke may be extracted and its spread to other areas will depend on differential pressure conditions (largely controlled by the capacity of the extract fan).

The fan may be turned off or fail due to overheating, but even during operation of the fan the quantity of air drawn through the unaffected areas of the system towards the fire will be progressively reduced because the gases in the fire room will expand and this will increase the possibility of smoke spread against the flow. After cut-out of the fan, smoke spread can extend in either direction depending on differential pressures in the system. Once fire dampers are closed the problem is restricted to one compartment.

5.2.1.3 *Spread of smoke through the supply system and possible effects of the air supply*

The supply air is likely to be maintained until the fan is either automatically or manually cut off. While the pressure can be maintained positive relative to the fire area, the likelihood of smoke spread is greatly reduced, particularly if the supply grilles are placed at floor level or just above. In a very well sealed room, however, expansion pressures due to a fire may overcome the fan pressure. Once fire dampers are closed the problem is restricted to one compartment.

Although there is theoretically a risk of the air supply increasing the severity of a fire, ventilation flows are generally small relative to the air supply required by the fire and the ventilation caused by the fire itself, for example by the shattering of windows.

5.2.2 ***Fire within the ductwork system***

5.2.2.1 *Causes of fire within the ductwork system*

5.2.2.1.1 *Extract systems*

Fire may be drawn into the system or may develop within it as follows.

a) Flames and hot gases may be extracted from the room or diffuse into the system depending on relative pressure conditions.

b) Hot sparks diffusing or drawn into the ductwork may ignite combustible insulation, filters, deposits, etc. within the system, or hot gases may undergo spontaneous ignition when mixing with air from, for example, a branch of the ductwork system.

c) Heat conducted through the wall of the ductwork (during repair, etc.) may ignite combustible insulation, filters, deposits, etc.

5.2.2.1.2 *Supply systems*

A supply system may spread fire as follows.

a) Fan room fires may cause sparks or flame to travel through the system igniting combustible insulation, deposits, etc.

b) Fires within the room or space in which the ductwork is sited may cause ignition of combustible insulation, filters, deposits, etc. by heat conduction through the ductwork wall.

c) Fire may enter the system against the flow, given high overpressures within the fire room or space.

5.2.2.1.3 *Ductwork without forced flow*

In ductwork without forced flow, the situation is the same as that where the circulation fan is cut off, or where fire dampers at compartment walls or floors have isolated the compartment.

5.2.2.2 *Fire spread within the ductwork system*

The movement of flames and fire gases is similar to that of hot smoke as described in **5.2.1.1**. Where natural convection, buoyancy or expansion effects are sufficient to overcome the air velocity whilst the fan is still working, fire can spread over any combustible material within the ductwork against the air flow, assisted in this case by radiated heat and fully oxygenated air. Where combustible lightweight insulating material is used as a lining to a duct wall, this can result in rapid fire spread.

5.2.3 *Break-in of fire into the ductwork system*

The potential for this situation occurring where ductwork (be it supply or extract) passes through a room or space which is affected by fire is limited if there are no openings (e.g. grilles) into the ductwork, provided that the integrity of the ductwork remains unimpaired, and combustible insulation, filters, deposits, etc. are not present within the ductwork. Failure of integrity of the ductwork at any point can cause fire within the ductwork system.

The causes of fire breaking into the ductwork may be summarized as follows:

a) ignition of materials within the ductwork by heat conduction;

b) failure of the integrity of the ductwork, for example by failure of joints or flexible connections, due to thermal expansion or failure of the support system.

5.2.4 *Fire spread by ductwork into adjoining areas*

There is a potential for fire spread into adjoining areas when uninsulated ductwork containing fire or hot gases passes through a room or space unaffected by fire but within which there are combustible materials adjacent to the ductwork.

6 Design and construction

6.1 Risks associated with ductwork systems in different types of buildings

6.1.1 *Dwelling houses*

Two storey houses rarely include complicated ventilation systems. They may have a circulated warm air heating system or ducted extracts from cooker hoods. It is not, therefore, considered necessary for ductwork within one and two storey houses to have any specific protection against fire.

For houses with three or more storeys there is an increased risk of fire and of products of combustion spreading into the stairway whether by way of forced convection, natural convection or fire induced convection. Consequently recommendations are made in **6.7** limiting the positioning of transfer grilles, and regarding ducting of return air from protected stairways, provision of room thermostats, etc.

6.1.2 *Flats and maisonettes*

The particular problem of this type of occupancy (in addition to those applicable to dwelling houses, see **6.1.1**) lies in ensuring that, where common ductwork is provided, fire in one dwelling will not cause fire gases, etc. to penetrate another dwelling. In multi-storey blocks internal service cores increase the hazard but, more significantly, high buildings can develop large pressure differentials due to wind, temperature differences, etc.

Shunt systems (see **6.4.7**) are sometimes employed in blocks of flats and maisonettes to enable branch ductwork to be connected to main ductwork without the use of fire dampers. The design, based on the principle of pressure difference in a stack situation, is intended to retard the passage of a fire from one dwelling to another via the ductwork.

6.1.3 ***Institutional buildings***

In this occupancy group, buildings having a large number of rooms predominate, with occupants having a widely varying degree of mobility and capacity for a logical response to an emergency situation. Escape times can be protracted in comparison with most other occupancies due to occupants not being able to help themselves; indeed, in some cases they may be restrained. In such cases not only should every effort be made to ensure that smoke and decomposition products do not enter the ventilation system, but it is advisable to consider using the system as a positive means of confining smoke in certain areas, and hence keeping escape routes freely usable. Certain government departments, for example the Home Office and NHS Estates, publish guidance documents for buildings within their areas of responsibility that include recommendations for ventilation systems.

6.1.4 ***Other residential buildings, e.g. hotels and hostels***

As with institutional buildings, a large number of small rooms predominate in this type of building and there is a high risk of fire being transmitted by means of the ventilation ductwork system. Whilst the mobility of residents may be unrestricted, their unfamiliarity with the premises and their longer response times, should they be asleep, increase the life risk.

6.1.5 ***Assembly buildings, shops and offices***

6.1.5.1 Such buildings usually include large unobstructed areas, and smoke spread throughout a compartment is more likely to occur through such open spaces rather than by means of the ventilation ductwork system.

6.1.5.2 Ductwork systems in premises used for public entertainment should be arranged so that fire and/or smoke cannot transfer through ductwork from any other part of the building into:

a) areas occupied by members of the public; or

b) protected escape routes used by the public;

for a period of time equal to the fire resistance time of the element of the building construction through which the duct passes, or at least half an hour.

This should be achieved by fire protecting the ductwork using method 2 or method 3 (see **6.2.3** and **6.2.4**).

Fire dampers should not be installed in any ductwork provided to extract or release smoke from the building.

Where possible ductwork should not be sited within protected escape routes. Further recommendations are given within BS 5588-6.

6.1.6 ***Industrial and other non-residential buildings***

Suitably positioned fire dampers are usually sufficient to counter the dangers associated with the spread of fire through ventilation ductwork systems in these occupancies. Such fire dampers could also play a part in preventing damage to contents and the buildings themselves. Certain areas of such buildings involving storage or use of hazardous, corrosive, toxic or highly flammable substances require special consideration that is outside the scope of this standard (see BS 5908).

6.2 Methods for the protection of ventilation ductwork

6.2.1 ***General***

Fire protection of ventilation ductwork is needed as an integral part of compartmentation and to ensure that means of escape from the building are not prejudiced. There are three basic methods, and these are detailed in **6.2.2**, **6.2.3** and **6.2.4**.

The three methods are not mutually exclusive and it will be found that in most ductwork systems a combination of two, and occasionally all three, will best combat the potential fire dangers.

6.2.2 ***Method 1. Protection using fire dampers***

The fire is isolated in the compartment of origin by the automatic actuation of fire dampers within the ductwork system. Fire dampers should therefore be sited in the duct at the point where it penetrates a compartment wall or floor, or at the point where it penetrates the enclosure of a protected escape route.

6.2.3 ***Method 2. Protection using fire-resisting enclosures***

A building services duct is provided through which the ventilation ductwork passes and, if the duct is constructed to the highest standard of fire resistance of the structure which it penetrates, it forms a compartment known as a protected shaft. This method allows a complicated multiplicity of services to be transferred together along a duct traversing a number of compartments and reaching remote parts of a building, without requiring further internal divisions along its length. The provision of fire dampers is then required only at points where the ventilation ductwork leaves the confines of the protected shaft.

NOTE Care in the design of the ductwork system is necessary to ensure that expansion of the ductwork will not cause failure of the fire-resisting enclosure, particularly when formed by a suspended ceiling.

6.2.4 ***Method 3. Protection using fire-resisting ductwork***

The ductwork itself forms a protected shaft. The fire resistance may be achieved by the ductwork material itself, or through the application of a protective material.

6.2.5 ***Fire protection of ductwork***

6.2.5.1 *Commentary*

Method 1 does not require the ductwork to provide any degree of fire resistance since compartmentation is maintained by siting fire dampers whenever the ductwork penetrates a compartment boundary. Precautions or restrictions on design, necessary for fire considerations within a single compartment, vary widely and although some types of ductwork are not covered by the recommendations of this code, advice on their use is published elsewhere; for example specific performance requirements have been drawn up by the Health and Safety Executive (HSE) for ductwork designed for use in areas in which highly flammable liquids are stored (see reference [1]).

Whilst the main risk of fire transfer by means of ventilation ductwork is from a fire originating outside the ductwork, it is possible for a fire to originate inside the ductwork. To cater for this possibility, it is necessary to ascertain the resistance of the ductwork to a fire originating on either side of the ductwork wall.

Metal ductwork, if satisfactorily constructed and supported, will be able to provide a high degree of resistance to the passage of smoke and decomposition products. However, rapid transfer of heat through the metal, regardless of its thickness, prevents the ductwork achieving any degree of fire resistance without supplementary insulation. The method of test described in BS 476-24 takes into account the effect of fire entering the ductwork as well as fire exposure from the outside, and also subjects the ductwork suspension to fire.

6.2.5.2 *Recommendations for ductwork protected by method 2*

NOTE No recommendations are given for ductwork protected by method 1 as this relies on the provision of fire dampers for the maintenance of fire-resisting separation.

6.2.5.2.1 The fire resistance of the ductwork enclosure, when tested from either side should be not less than the fire resistance required for the elements of construction in the area through which it passes, unless the provisions given in **6.2.5.2.2**, or those given in **6.2.5.2.3**, apply.

6.2.5.2.2 If the following provisions apply:

a) there are no combustible materials, such as insulation, between the ductwork and the enclosure; and

b) the enclosure facings are constructed from materials of limited combustibility;

then the fire resistance of the ductwork enclosure when tested from either side should be not less than one half of the fire resistance required for elements of construction in the area through which it passes, and in no case should it be less than 30 min.

6.2.5.2.3 Alternatively, if the following provisions apply:

a) the junction between the floor and the ductwork at every storey level is fire-stopped; and

b) there are no combustible materials, such as insulation, between the ductwork and the enclosure; and

c) the enclosure facings are constructed from materials of limited combustibility;

then the fire resistance of the ductwork enclosure when tested from the outside should be not less than the fire resistance required for the elements of construction in the area through which it passes.

6.2.5.3 *Recommendation for ductwork protected by method 3*

The fire resistance of the ductwork, when tested from either side, should be not less than the fire resistance required for the elements of construction in the area through which it passes.

6.3 Fire dampers

6.3.1 *Fire resistance*

6.3.1.1 *Commentary*

It has been found that the failure of a fire damper or its frame under the test conditions described in BS 476-20 is most likely to take place within the first hour, and that fire dampers which meet the criterion for integrity after 60 min will continue to do so for some considerable time. Though intumescent dampers may satisfy any heat insulation requirements, mechanical fire dampers may not, although the provision of two mechanical fire dampers with an air space between them normally improves the thermal performance.

Fire dampers are not generally regarded as being fully effective in resisting the penetration of smoke, although their use for fire integrity purposes will assist in reducing or retarding the movement of smoke.

6.3.1.2 *Recommendations*

All fire dampers and their frames, when subjected to the test conditions described in BS 476-20, should satisfy the fire integrity criterion for not less than 60 min.

NOTE BS ISO 10294-1, ISO 10294-2 and ISO 10294-3 provide further guidance on test methods.

6.3.2 *Operation*

6.3.2.1 *Commentary*

Fire dampers should be simple in their operation, with the minimum number of moving parts. Fire dampers employing channels and grooves to house sliding blades are susceptible to accumulation of dirt and other deposits and are not suitable for some situations, for example an extract from a sawmill or a kitchen.

All fire dampers referred to in this standard need to close automatically under emergency conditions. Mechanical fire dampers should be held open by a thermally activated device, although they may also be activated by a smoke detector. Intumescent dampers by their nature are thermally activated and should be demonstrated to close within the time permitted in the time temperature curve given in ISO 834-1.

Intumescent dampers may also incorporate electrically operated moving components which when activated by a smoke sensor will provide a smoke barrier, prior to the intumescent elements activating.

Closure may be achieved in many ways including gravity operation or with spring assistance. In the latter case springs need to be securely fixed and protected from the fire gases so as to exert and maintain the requisite pull both for the working life of the fire damper and, during a fire, for the period prior to the closure of the fire damper.

Thermally actuated devices need to be arranged so that, on operation, any released parts do not impede the movement of the fire damper. The linkage and fixings need to be of adequate strength to avoid the need for renewal other than following test or emergency operation. The link will only be effective if arranged in a position fully exposed to the hot gas stream within the protected opening, and not shielded by damper blades or other component parts.

6.3.2.2 *Recommendations*

All mechanical fire dampers should be held in the open position by means of a thermally actuated device set to operate at approximately 74 °C and located in a fully exposed position within the protected opening.

6.3.3 ***Actuation of fire/smoke dampers by smoke detectors***

6.3.3.1 *Commentary*

It should be appreciated that thermally actuated devices operate only on attaining a certain temperature and may not therefore operate in the presence of smoke alone, and that a slow burning fire or an admixture of cool air with smoke and fire gases may result in appreciable quantities of smoke passing the fire damper before the thermally actuated device operates.

There are positive advantages in life safety terms in actuating fire/smoke dampers by smoke detectors in addition to thermally actuated devices, particularly in buildings presenting a high or special life hazard such as hotels, hospitals and other non-domestic buildings involving a sleeping risk. Smoke detectors of either the optical or ionization chamber type may be used to actuate the fire/smoke dampers.

Care is needed in the selection of the model(s) and number of smoke detectors and their siting, as various factors affect satisfactory operation. In particular, the density of smoke within ventilation ductwork is likely to be considerably reduced by dilution with air (to a greater degree in high velocity systems) with a consequential delaying effect on the operation of the detector. Smoke detectors may, therefore, be better situated in a room or other part of the building rather than within ventilation ductwork, although in recirculating systems a smoke detector should always be installed within the ductwork (see **6.6**). Information on the siting of smoke detectors is given in BS 5839-1:1988, in particular in **13.2.16** and **13.4.2**.

It is important that the controlling authorities are consulted before deciding whether detection of smoke should result in particular fire/smoke dampers being closed, all the fire/smoke dampers in that compartment being closed, or all the fire/smoke dampers in the building being closed.

Detectors of the ionization chamber type may be sensitive to the air flow velocity and consequently when detectors of this type are proposed for use in ductwork, the housing or associated probe should be suitable for the air flow velocity involved.

6.3.3.2 *Recommendations*

6.3.3.2.1 *General*

Where the use of the building presents a high or special life hazard, i.e. it is used as an hotel, hospital or other building involving a sleeping risk (other than blocks of flats or maisonettes), fire/smoke dampers should be actuated by smoke detector controlled automatic release mechanisms in addition to being actuated by thermally actuated devices.

6.3.3.2.2 *Hotels and similar premises*

Hotels and similar premises where people reside for limited periods are, owing to the occupants' unfamiliarity with their surroundings, places of high risk. It follows therefore, that additional measures will be needed to provide an acceptable level of safety to the occupants of the building.

Smoke detector operated fire/smoke dampers should be installed in the ductwork. They should be located so as to ensure that smoke is not transferred through ductwork which penetrates fire-resisting constructions.

However, in a situation where all occupants of the building can be expected to make an unaided escape, and an L1 fire alarm system is installed in accordance with the recommendations given in BS 5839-1:1988, the following exceptions may be made.

a) If the alarm system is arranged so that on the detection of smoke it signals the immediate evacuation of all the occupants of the building, then fire/smoke dampers are not needed.

b) If the building is divided into fire compartments and the alarm system is arranged to signal the immediate evacuation of the occupants of the fire compartment in which the fire has been detected, then smoke detector operated fire/smoke dampers need only be provided where ductwork which forms part of the ventilation system enters or leaves the fire compartment.

6.3.3.2.3 *Hospitals and other buildings involving a sleeping risk (other than blocks of flats and maisonettes)*

Smoke detectors within the rooms should activate the appropriate fire/smoke dampers to prevent smoke being transferred between fire compartments.

See also:

— Health Technical Memorandum 81, *Fire precautions in new hospitals* [2];

— Health Technical Memorandum 85, *Fire precautions in existing hospitals* [3].

6.3.3.2.4 *Entertainment premises*

Where the provision of fire/smoke dampers cannot be avoided in supply ventilation systems and extract systems serving public areas in entertainment premises, other than those systems where fire dampers should not be provided (see **6.1.5.2**) the dampers should be activated by smoke detector controlled automatic release mechanisms.

Smoke detectors and automatic release mechanisms used to actuate fire/smoke dampers should conform to BS 5445-7 and BS 5839-3 respectively. Smoke detectors should be sited so as to detect smoke before it enters public areas.

6.3.4 ***Installation***

6.3.4.1 Fire dampers should be installed within ventilation ductwork in the following situations (see **6.2**).

a) *Method 1. Unprotected ductwork.*

Wherever the ventilation ductwork passes through a fire-resisting wall or floor or any other fire-resisting division, e.g. walls to escape routes, cavity barriers.

b) *Method 2. Ductwork in a fire-resisting enclosure.*

At all points at which the ventilation ductwork passes through the fire-resisting enclosure.

c) *Method 3. Fire-resisting ductwork.*

Wherever the ventilation ductwork is penetrated by an unprotected branch, inlet or outlet.

NOTE Figure 2, Figure 3 and Figure 4 illustrate examples showing fire damper positions for the three methods.

6.3.4.2 Fire dampers should not be installed in extract ductwork serving:

a) non-domestic kitchens;

b) car parks.

6.3.4.3 Fire dampers do not need to be installed in the following situations:

a) in vertical ductwork serving sanitary accommodation only, provided that:

1) the toilet accommodation is completely enclosed by construction having a fire resistance equal to that required for structural elements within the building; and

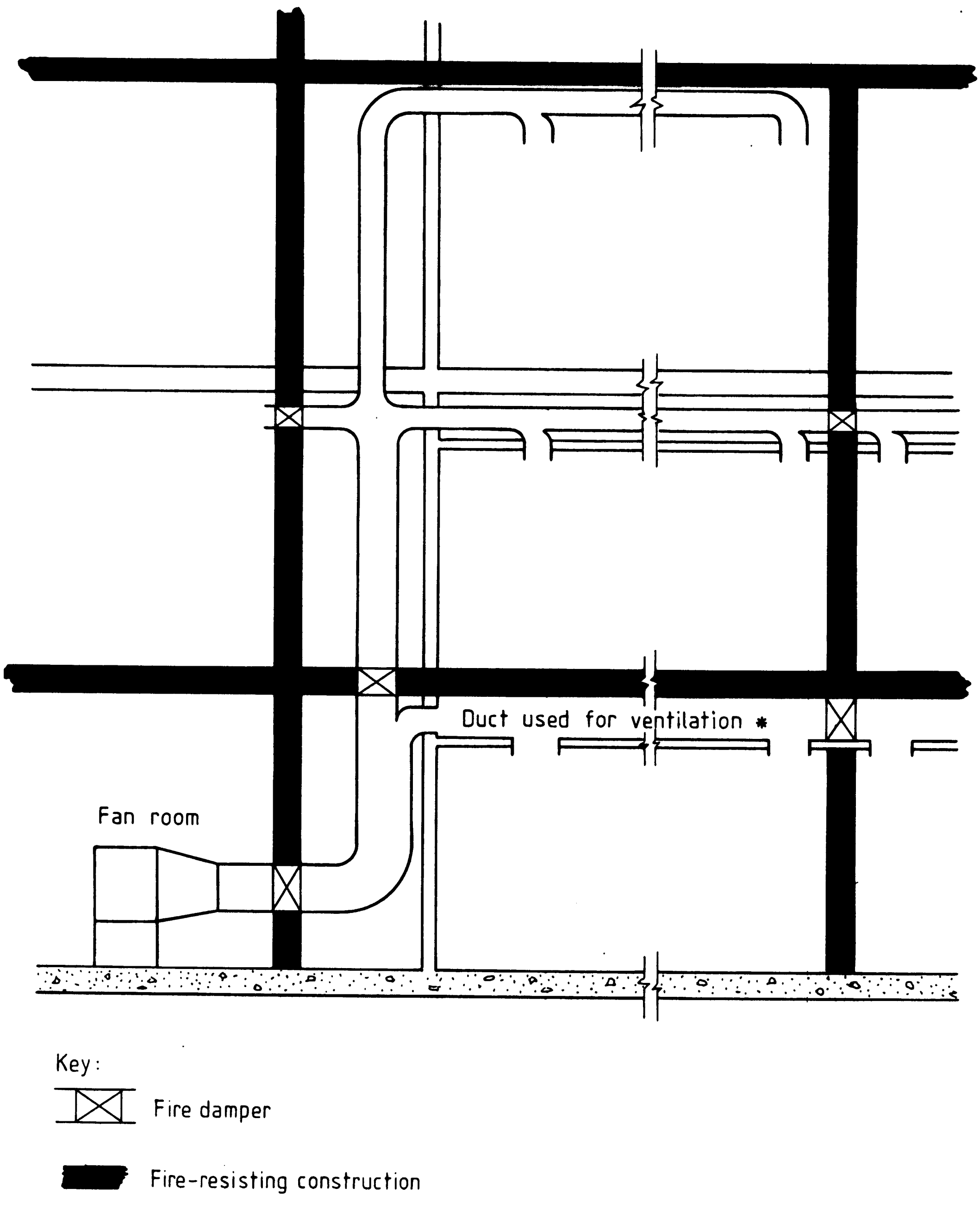
2) the ductwork is wholly contained within the sanitary accommodation; and

3) the doors in the enclosing walls are fire-resisting (FD30 i.e. having 30 min fire integrity when tested in accordance with BS 476-22) and self-closing;

b) in shunt systems (see **6.4.7**).

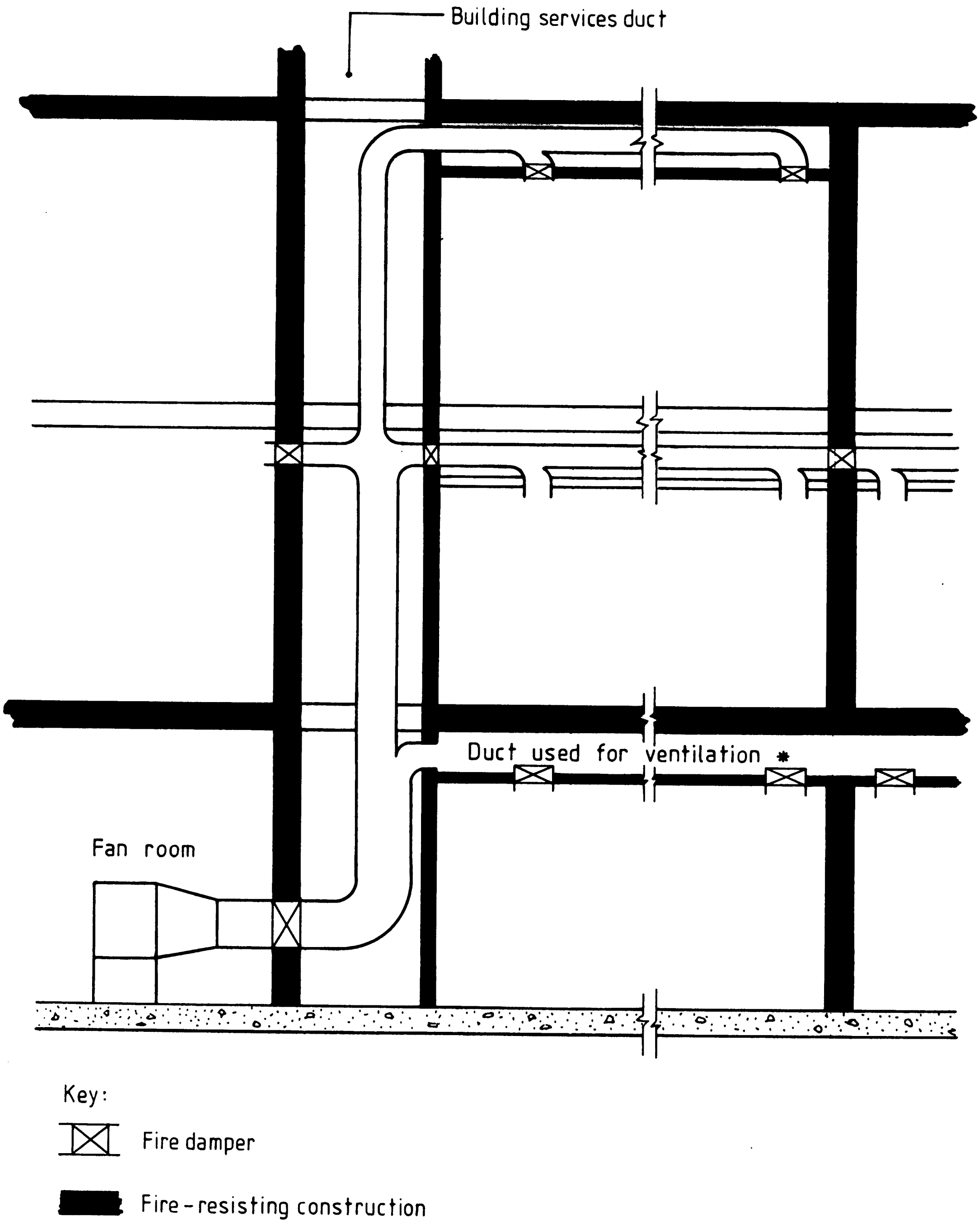
6.3.4.4 All fire damper leaves should, when shut, fit closely against their frames with an overlap. The gap between a fire damper leaf and its frame should not be materially greater than that necessary to allow for thermal expansion, and pivot blade fire dampers should close in the direction of air flow.

NOTE Pivot blade fire dampers have been found to be satisfactory if the overlap is not less than 19 mm and the clearance between the edge of the damper and the frame is equal to 1/100 of the length of the damper side or of the damper diameter, as applicable.



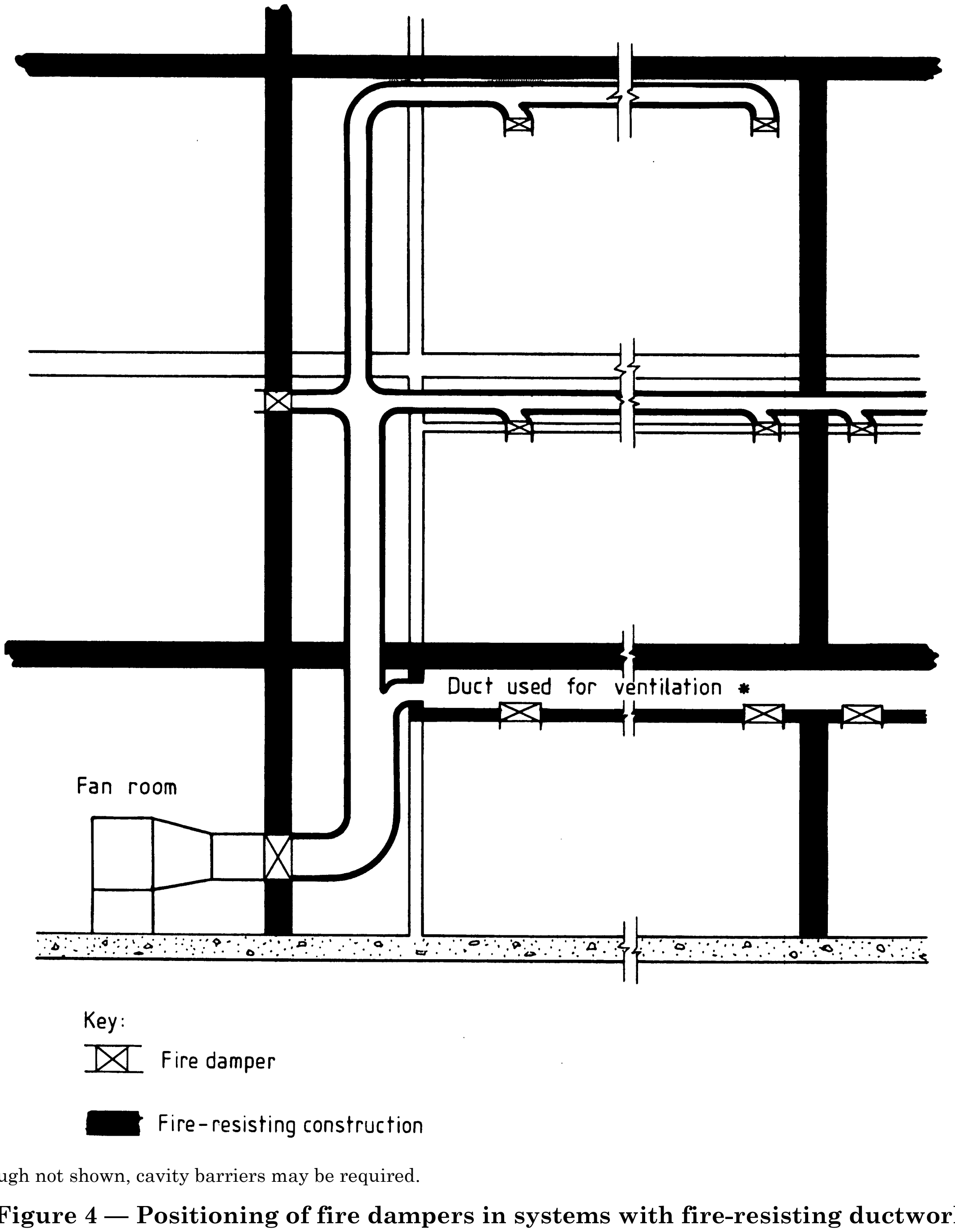
* Although not shown, cavity barriers may be required.

Figure 2 — Positioning of fire dampers in systems with unprotected ductwork



* Although not shown, cavity barriers may be required.

Figure 3 — Positioning of fire dampers in systems where the ductwork is protected by a fire-resisting enclosure



* Although not shown, cavity barriers may be required.

Figure 4 — Positioning of fire dampers in systems with fire-resisting ductwork

6.3.4.5 Fire dampers and their framework should be situated within the thickness of the fire-resisting wall or floor, with the frame of the fire damper either securely fixed thereto or mounted and fixed in a damper sleeve unit which is securely built into the wall or floor. Where double fire dampers are installed, and cannot be arranged to close within the thickness of the wall or floor, they should be fixed in a section of ductwork which is designed as a damper box. The damper box should be sited immediately adjacent to the floor or wall and be constructed and supported to the same level of fire resistance as the floor or wall.

6.3.4.6 Provision should be made, where necessary, for expansion of the framework by means of slotted fixing holes, lead washers, etc. Where the structure containing the fire damper is not robust it is also necessary to ensure that, in a fire, expansion of the ductwork would not push the fire damper through the structure.

6.3.5 *Corrosion*

6.3.5.1 *Commentary*

Corrosion is basically a reaction between metal and its environment; hence most metals used for fire dampers and their framework construction will be subject to corrosion unless adequate precautions are taken.

6.3.5.2 *Recommendations*

All fire dampers should be protected against expected conditions of humidity by means of galvanising, suitable paint protection or other appropriate protective barriers.

NOTE It is desirable for bearings to be based on bronze with insulation, where necessary, to reduce the possibility of galvanic action.

6.3.6 *Access for maintenance and testing*

Wherever fire dampers are installed, adequate means of access should be provided in a convenient position adjacent to the fire damper. The access panel should be large enough to allow testing and maintenance of both the fire damper and its actuating mechanism.

[A1) NOTE Access to ductwork may also be required for firefighting purposes (A1].

6.4 Installation of ductwork systems

6.4.1 *General*

When ductwork systems are installed within a building it is important that the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas.

Any exhaust points should be sited so as not to further jeopardize the building, in the event of a fire, i.e. away from final exits, combustible building cladding or roofing materials, and openings into the building.

6.4.2 *Fan rooms*

Any fan room not located within the space which it is dedicated to serve, within a building, should be enclosed with elements of construction having a level of fire resistance at least equal to that required for the part of the building within which it is situated, and in no case less than 1 h.

Any fan room adjoining a building (including on top of a flat roof) should be separated from the building by elements of construction with a fire resistance of not less than 1 h.

Any air handling unit within a building should be enclosed with elements of construction having a level of fire resistance at least equal to that required for the part of the building within which it is situated, and in no case less than 1 h.

A fire damper should be provided where the ventilation ductwork penetrates the wall or floor of the fan room.

6.4.3 *Ductwork passing through or serving protected escape routes*

Ventilation ducts and their associated plant supplying or extracting air directly to or from a protected escape route, should not also serve other areas. A separate ventilation system should be provided for each protected stairway.

Where the ductwork system serves more than one part of a compartmented or fire separated protected escape route, smoke detector operated fire dampers should be provided where ductwork enters each fire or smoke separated section of the escape route. The smoke detector operated fire dampers should be caused to close should smoke be detected within any part of the escape route. Any ductwork passing through an accommodation space should be fire-resisting, i.e. the ductwork should be constructed in accordance with method 2 or method 3, (see **6.2**).

Any ductwork passing through a protected stairway, lobby or corridor, without ventilating that area, should be fire-resisting, i.e. the ductwork should be constructed in accordance with method 2 or method 3, (see **6.2**).

In single stairway buildings the ductwork enclosure should be imperforate where it passes through the stairway or any protected lobby or protected corridor.

In multi-stairway buildings, ductwork access panels within protected escape routes should not reduce the fire resistance of the ductwork enclosure from the inside.

NOTE See also **6.8** for information and recommendations regarding transfer grills.

6.4.4 ***Use of service ducts for ventilation purposes in addition to the distribution of services, and the use of ventilation ductwork for other services***

6.4.4.1 *Commentary*

The use of ductwork or ducts for services other than ventilation in a building raises a number of issues that have fire implications and need to be considered at the design stage. They include the following:

a) the possibility that gases, vapours or liquids may escape from pipes and be transported round the building;

b) the possibility that services within ventilation ductwork may make the ductwork more difficult to clean, thus increasing the likelihood of a build-up of ignitable materials.

The number of penetrations of the enclosing structure by the ductwork also needs to be taken into account at the design stage, together with any future penetrations by ductwork which are likely, due to foreseeable changes in the layout of the building.

6.4.4.2 *Recommendations*

The following recommendations are applicable.

a) Where a service duct enclosure is provided with a level of fire resistance in accordance with BS 8313, and the service duct itself is also used for ventilation purposes, any grille or opening through the enclosure for ventilation purposes should be protected by a fire damper.

b) Service pipes containing toxic or flammable substances should not be routed in, or through, ductwork provided for ventilation purposes.

6.4.5 ***Air handling voids***

6.4.5.1 *Commentary*

Air handling voids, which can be either supply or extract plenums, frequently contain combustible materials, for example PVC sheathing of electrical cables. In this situation there is a risk of the ignition of such materials by flames and hot gases being drawn through the air handling void or by ignition from the cables themselves.

6.4.5.2 *Recommendations*

6.4.5.2.1 *Ceiling voids*

Except in areas of special risk (see **6.4.6.1**), if the void above a false ceiling is used for the supply or extraction of air, a smoke detector should be fitted adjacent to each point where supply ductwork enters, or extract ductwork leaves, the storey/compartment in question. Such smoke detectors should:

a) trigger the closing of the fire damper provided to complete the fire separation; or

b) cause the vitiated air containing smoke to be diverted to the outside of the building (see **6.6.2**).

Where a plenum ceiling is not compartmented and exceeds 400 m^2 in area and is not provided with a smoke detection system conforming to BS 5839-1, the electrical wiring within the plenum ceiling should be enclosed in metal conduit or metal trunking or be unserved mineral-insulated metal-sheathed cables.

Ceiling voids in areas of special risk (see **6.4.6.1**), if used for the supply or extraction of air, need not be provided with a smoke detector, as the air should not be recirculated.

Any false ceiling panels in contact with the extracted air from non-domestic kitchens or from deep fat fryers should be easily removable for cleaning.

6.4.5.2.2 *Floor voids*

Where the void beneath a platform floor, subdivided by cavity barriers, is used for the supply or extraction of air, a sufficient number of smoke detectors should be provided to ensure that upon detection of smoke within any part of the floor void, the supply of air to the void, or extraction of air from the void, would cease.

6.4.6 *Segregation of ventilation ductwork serving areas of special risk or carrying polluted air*

6.4.6.1 *Commentary*

Certain areas of a building, for example non-domestic kitchens, car parks and plant rooms, need to have separate and independent extraction systems, and the extracted air should not be recirculated. Residential accommodation in mixed user buildings requires separate ventilation systems because of the sleeping risk involved. Certain appliances, such as deep fat fryers, need their own extract ductwork and it is essential that this ductwork is provided with access for cleaning at intervals not exceeding 3 m. As extract ductwork from kitchens should not be provided with fire dampers (see **6.3.4.2**), method 2 and method 3 (see **6.2**) are the only acceptable means for the protection of such ductwork against fire when immediate discharge to the outside of the building is not possible.

Air ductwork is an important part of many modern plant operations and is used for the disposal of flammable vapours, noxious fumes, and/or dusts. Such ductwork can be the site of origin of a fire, and can lead to fire starting in parts of the building through which the ductwork passes by igniting combustibles in contact with the ductwork, or by radiant heat. It is therefore important that ductwork conveying polluted air from an industrial process, or ductwork from frying areas in kitchens or from fume cupboards, is designed and sited in a manner that takes into consideration the particular hazard involved, and the possibility that such ductwork might contribute to the spread of fire throughout the building.

It is not however possible to give comprehensive recommendations in respect of ductwork from industrial processes. These will need to be considered in the light of the particular risk involved, and early consultation with the Health and Safety Executive is necessary.

6.4.6.2 *Recommendations*

The following recommendations are applicable.

a) Extract ductwork systems serving the following appliances or parts of a building should be entirely independent of each other and of any ventilation ductwork serving other parts of the building:

1) non-domestic kitchens;

2) deep fat fryers;

3) boiler chambers;

4) areas containing oil-immersed electrical plant;

5) car parks.

b) Any ventilation system supplying residential accommodation in a mixed user building (see, for example **6.1.5.2**) should be independent of any system supplying the other parts of the building.

c) Ventilation ductwork conveying polluted air, or servicing parts of a building considered to present a special fire hazard, should be independent of any other ventilation ductwork serving other parts of the building.

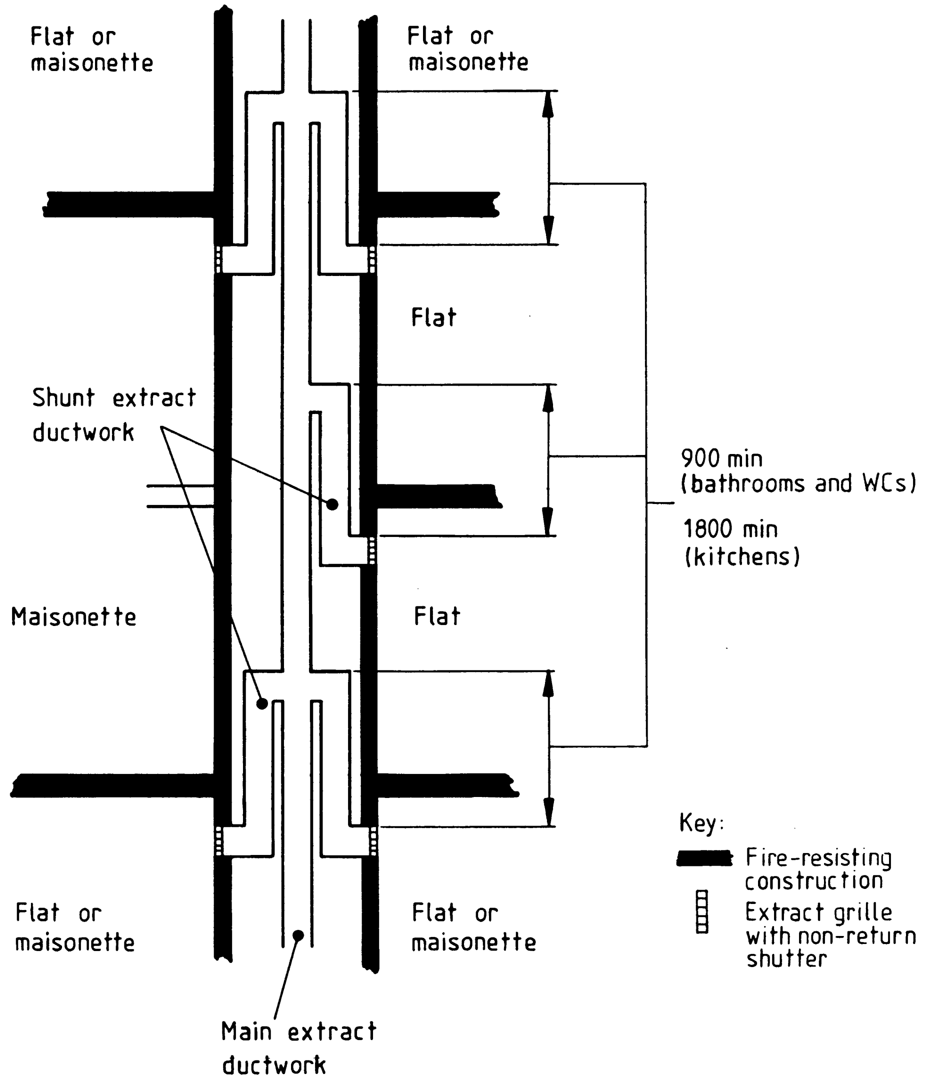
6.4.7 *Shunt systems*

6.4.7.1 *Commentary*

Shunt systems may be used to avoid the need to provide fire dampers in extract ductwork from bathrooms and WCs of flats and maisonettes. Because of the fire risk inherent in kitchens, shunt ductwork is not normally acceptable for use in kitchen extraction but, if used, careful consideration should be given to possible pressure differentials within the system to avoid the transfer of smoke and other products of combustion from one dwelling to another by means of the ductwork system.

NOTE Shunt systems are illustrated in Figure 5.

Dimensions in millimetres



Values are minimum values.

Figure 5 — Shunt systems

6.4.7.2 *Recommendations*

The following recommendations are applicable.

a) Shunt ductwork should be used only for extraction ductwork in flats and maisonettes.

b) The branch ductwork should be arranged as shunt ductwork so as to enter the main ductwork not less than 900 mm above the room extract grille in bathrooms and WCs, and not less than 1 800 mm above the extract grille in kitchens.

c) The extract grille should be provided with a non-return shutter.

d) The main ductwork and the vertical portion of the shunt ductwork should be contained within a protected shaft.

6.4.8 ***External ductwork and exhaust outlets***

6.4.8.1 *Commentary*

Care should be taken in the siting of external ductwork and exhaust points (grilles) in relation to unprotected openings and external escape routes to prevent extracted smoke being drawn back into the building.

6.4.8.2 *Recommendations*

The following recommendations are applicable.

a) Exhaust points should be sited away from inlet grilles, (for example inlet grilles for air conditioning systems) to prevent extracted smoke being drawn back into the building.

b) Exhaust points should be sited so as not to further jeopardize the building, in the event of fire, i.e. away from final exits, combustible building cladding or roofing materials, and openings into the building.

6.4.9 ***Fire-stopping***

Where ductwork protected using methods 1 and 3 (see **6.2**) or ductwork enclosures protected using method 2 (see **6.2**) pass through fire-resisting elements of construction, any gap should be adequately fire-stopped, for the full thickness of the enclosure, so that the level of fire resistance of the joint is not less than that of the fire-resisting element.

The choice of fire-stopping method and material should take into account longitudinal movement of the ductwork caused by the effects of fire.

6.5 Combustibility of materials and components

6.5.1 ***Commentary***

It is common practice to insulate metal ductwork for sound or thermal insulation purposes. Whilst sound insulation is usually applied as a lining within the ductwork, thermal insulation is usually applied external to the ductwork. Two methods of external insulation of ductwork are in common use; one is to apply the insulation to the ductwork itself, and the other is to fill the space between the ductwork and the ductwork enclosure with insulating material. Whichever method is employed, in a fire a very considerable amount of heat and smoke may be contributed by the insulation if it is combustible.

Whilst rigid metal ductwork offers some resistance to penetration by fire or smoke, it is usually necessary for the system to incorporate a number of flexible joints or connections, which are combustible. Each such joint or connection is a potential weak point in the system and therefore restrictions are necessary in their use.

Care is also necessary in the choice of components and in ensuring that materials in contact with or near to inadequately insulated ductwork do not ignite due to radiated or conducted heat generated from a fire within the ductwork.

6.5.2 ***Recommendations for insulation***

The following recommendations are applicable.

a) All insulation applied as an internal lining to ductwork should have a class 0 surface (see **3.4**) and be either:

1) a non-combustible material (see **3.14**); or

2) a material of limited combustibility (see **3.13**).

b) All external insulation should be in accordance with one of the following as applicable.

1) External insulation situated within a fire-resisting ductwork enclosure should have a class 0 surface, unless the space between the ductwork and the fire-resisting enclosure is subdivided at each floor level, and wherever the fire-resisting ductwork enclosure penetrates a compartment boundary, by fire-resisting construction with a fire resistance of not less than that of the ductwork enclosure.

2) External insulation not situated within a fire-resisting ductwork enclosure should have a rating for surface spread of flame of not less than that for the surface of the wall or ceiling which the ductwork traverses.

3) External insulation that is not in accordance with a) 1) or a) 2), should not be situated within 500 mm of a fire damper.

6.5.3 ***Recommendations for flexible joints and connections***

The following recommendations are applicable.

a) Flexible joints should:

1) not exceed 250 mm in length;

2) consist of, or be protected by, material which, when subjected to the test conditions described in BS 476-20, satisfies the fire integrity criterion for not less than 15 min.

b) Flexible connections should:

1) not exceed 3.7 m in length;

2) not pass through fire-resisting walls or floors, or cavity barriers;

3) either:

i) be constructed of non-combustible material; or

ii) be constructed of material which, when tested in accordance with BS 476-6, has a fire propagation index I of not more than 12 and a sub-index i_1 of not more than 6, and be situated at least 1 m from any fire damper.

6.5.4 ***Recommendations for components***

The following recommendations are applicable.

a) Surfaces of air filters, air attenuators and similar components of ventilation systems exposed to the airflow should be inherently non-flammable or so treated as to make them non-flammable for the duration of their recommended working life.

b) Viscous fluids in air filters should have a flash point of not less than 177 °C.

6.6 Recirculating distribution systems

6.6.1 ***Commentary***

In any system of air conditioning where vitiated air is recirculated from one part of the building to another, precautions are necessary to prevent the distribution of smoke and hot gases throughout the building. This is usually achieved by the installation of smoke detectors linked to the ventilating system controls so that when a detection of smoke signal reaches the plant room either the air will be discharged to the open air or the system will be immediately shut down.

NOTE Advice on the selection and installation of smoke detectors in ductwork is given in BS 5839-1:1988, **12.4.2**.

6.6.2 *Recommendations*

The following recommendations are applicable.

a) One or more smoke detectors should be fitted in the extract ductwork before the point of separation of the recirculated air and the air to be discharged to the open air, and before any filters or other air cleaning equipment. Such detector(s) should, if the smoke reaches an optical density of 0.5 db/m, be capable of either:

1) causing the system to immediately shut down; or

2) switching the ventilation system from recirculating mode to extraction to open air, so as to divert the vitiated air containing any smoke to the outside of the building.

b) On triggering of the smoke detection system, the supply system should be switched off and the exhaust system should continue to run. This mode of operation will allow smoke to be extracted from the space and away from exit ways until the system breaks down or a fire damper closes.

NOTE 1 Care should be taken that this action will not cause excessive negative pressure within the space and require a force in excess of 100 N to be applied to the door handle to open the doors on the route of escape.

NOTE 2 If the smoke detectors are connected to the general fire alarm system, the method for resetting the ventilation plant after operation of the fire alarm should be completely separate from the method for resetting the fire alarm.

6.7 Domestic heating, ventilation and air conditioning (HVAC) systems

6.7.1 *Commentary*

The system usually comprises ductwork serving various rooms and circulation areas, with transfer grilles as necessary to balance the system. Risk can arise from a fire starting in the accommodation, or possibly in the heating or air conditioning unit. However, in either case there is potential for smoke to spread readily to all parts of the dwelling unless appropriate safeguards are incorporated in the system.

It is necessary to ensure that the ductwork does not allow for direct air transfer between accommodation areas and the escape route(s) within the dwelling; that transfer grilles and any return air grilles between rooms are situated at a low level to retard smoke spread; and that the air circulation fan is thermostatically controlled to switch off when there is a temperature rise in the dwelling sufficient to suggest a fire condition.

Recommendations are made in respect of those types of dwellings where, because of the need for a protected entrance hall or stairway, smoke spread by means of the system would be likely to pose a special hazard.

6.7.2 *Recommendations*

Where the dwelling is provided with a system of circulated warm air heating, the circulated warm air heating system should conform to the following, as applicable.

a) In any house that has at least one floor situated more than 4.5 m above ground level, the system should conform to BS 5588-1:1990, Clause **6**.

b) In any flat or maisonette that has a protected entrance hall or stairway, the system should conform to BS 5588-1:1990, Clause **15**.

6.8 Transfer grilles

6.8.1 *Commentary*

Whilst air transfer grilles in walls, partitions, doors, etc. are not part of ventilation ductwork, they may form essential components of an air distribution system in a building.

Care needs to be taken in the positioning of transfer grilles to ensure that they do not allow the passage of fire and smoke. In general, therefore, the installation of transfer grilles should be avoided in any construction required to be fire-resisting, particularly those forming compartment boundaries. Where it is necessary for transfer grilles to be fitted with fire dampers the recommendations for construction of fire dampers should be followed (see **6.3**).

6.8.2 ***Recommendations***

The following recommendations are applicable.

a) Transfer grilles should not be installed in:

1) elements of construction enclosing compartments or protected shafts;

2) enclosures to protected stairways, protected lobbies, protected corridors, firefighting stairways or firefighting lobbies;

3) bedroom walls or doors.

b) Transfer grilles fitted in any construction required to be fire-resisting should be fitted with fire dampers.

6.9 Firefighting control

To ensure the effective use of mechanical ventilation systems, override controls should be provided for fire service use. It is essential that the provision, location and the mode of operation of such facilities are discussed and agreed with the approving authority and the designer of the systems, the user of the premises and the building control authority before any decision is made to provide override facilities for either fire safety or normal air handling systems.

The controls for the ventilation system should be located adjacent to the fire alarm panel. The following should be clearly marked, where applicable:

— "Fire service ventilation control";
— "Automatic";
— "Off";
— "Extracts only".

The signage should be in accordance with BS 5499-1.

7 Advice to management

[A1) Management is now dealt with in BS 5588-12. (A1]

Bibliography

Standards publications

BS 5908, *Code of practice for fire precautions in the chemical and allied industries.*

BS ISO 10294-1:1996, *Fire resistance tests — Fire dampers for air distribution systems — Part 1: Test method.*

ISO 10294-2[1)], *Fire resistance tests — Fire dampers for air distribution systems — Part 2: Classification, criteria and field of application of test results.*

ISO 10294-3[1)], *Fire resistance tests — Fire dampers for air distribution systems — Part 3: Explanatory document.*

Other publications

[1] HSE Certificate of approval No. 1 to the Highly Flammable Liquids and Liquefied Petroleum Gases Regulations 1972; Part V: Ducts, trunks and casings required to be fire-resisting structures.

[2] NHS ESTATES. Health Technical Memorandum 81, 1996. *Fire precautions in new hospitals.*

[3] NHS ESTATES. Health Technical Memorandum 85, 1994, *Fire precautions in existing hospitals.*

1) In preparation.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

Details and advice can be obtained from the Copyright & Licensing Manager. Tel: +44 (0)20 8996 7070. Fax: +44 (0)20 8996 7553. Email: copyright@bsi-global.com.

BSI
389 Chiswick High Road
London
W4 4AL