

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

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

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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 It supersedes BS 5588-9:1989 which is withdrawn.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.

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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, ^[A] construction and use ^[A] of buildings — Part 1: Code of practice for residential buildings.*

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

^[A] Text deleted ^[A]

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.