BB100
DESIGNING AND MANAGING AGAINST THE RISK OF FIRE IN SCHOOLS

Courtesy of Staffordshire Fire and Rescue Service
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SCOPE AND PRINCIPLES

This guidance on fire safety design covers all schools maintained by Local Educational Authorities (LEAs) in England and Wales: that is nursery schools, primary and secondary schools, boarding schools, community, community special and voluntary schools as well as pupil referral units. It also provides useful advice for the design of independent schools. The guidance is aimed at head teachers and governing bodies of schools, LEAs, design consultants, building control bodies, the Fire and Rescue Service and to all those involved in the design and management of schools.

Figures from the Office of the deputy Prime Minister (ODPM) show that over 1300 school fires a year in England and Wales are attended by local authority Fire and Rescue Services. Around 70% of these are started deliberately. We therefore need to greatly reduce the risk of fires occurring in schools and, when a fire does occur, reduce the risk of it spreading. This guide shows how to do that through good design and management. While our primary concern is for the safety of the users of school buildings, a fire can have a serious impact on children’s education due to disruption and loss of course work. This guide therefore gives advice on property protection as well as life safety issues.

Generally all new building work in schools is subject to approval under the Building Regulations, which are based on functional requirements. The principles followed in this guide are based on identifying and assessing the risks presented in the different areas of a school and, where necessary, taking action to reduce them. This document provides practical guidance for designers on the use of robust alternatives in areas such as materials specification, on fire detection and suppression systems, and highlights the importance of interaction with other regulatory requirements, such as those for the disabled.

While the guide concentrates on new school building work, the principles can be applied to extensions to existing buildings and major refurbishments where these create a material alteration to existing buildings and affect means of escape. The extent to which this guidance should be applied to extensions or refurbishments will very much depend on individual circumstances.

Building Bulletin 95 Schools for the future provides guidance on the accommodation needs of education in the 21st Century. Two of the issues it embraces are inclusion, where a wide range of pupils, aged three to sixteen years, attend the school full time and community where there is extended use of the building(s) part-time by all age groups. Design quality and sustainability are also issues - high quality, attractive, long-life buildings are needed to appeal to a wide range of users. Fire losses in these buildings can only be reduced through a combination of good design and increased security and good management.
PART 1 GENERAL

Since the withdrawal of Building Bulletin 7 Fire and the design of educational buildings in November 1997 the Department for Education and Skills (DfES) and its predecessors, has published a series of Building Bulletins providing design guidance on a range of issues in schools. Maintained school buildings are subject to normal building control procedures having lost their exemption from Building Regulations in April 2001.

This Part summarises the regulatory background and existing guidance on fire safety in schools. Also outlined is the use of the five-stage risk assessment cycle during the design process. This provides a way of identifying risks and selecting measures to control and manage those risks.

1.1 Regulatory background
1.2 Responsibilities
1.3 Existing guidance
1.4 Fire safety issues
1.5 Risk assessment - the five stage cycle

1.1 REGULATORY BACKGROUND

Since April 2001, all new building work in schools has been subject to approval under the Building Regulations. These regulations used to be prescriptive, but are now performance-based, or functional. If a building is designed in accordance with Approved Document B (Fire Safety) (ADB), a satisfactory standard of life safety will be achieved together with a minimum of property protection. In this document we will refer to ADB as a way of achieving a base line for life protection, while also suggesting ways of improving property protection.

The Workplace (Health, Safety and Welfare) Regulations 1992 put the onus of occupant safety onto the employer, which is leading to better awareness of the risk of fire. The Fire Precautions (Workplace) Regulations 1997 (as amended 1999) placed the onus on the building owner and user as well as the employer, which may be the LEA, the governing body or, with an independent school, the proprietor. Generally speaking the emphasis in the guide will be on the duties of the employer. The Home Office/HSE Fire Safety An employer’s guide 1999 is a useful adjunct to this guidance document. Under the Regulatory Reform Order 2002 fire safety legislation is becoming simplified and a suite of guides is being prepared for different occupancies. These deal with the provision and management of fire safety in existing buildings; the one for schools should be available in 2005.

1.2 RESPONSIBILITIES

The DfES document Health & Safety: Responsibilities and Powers (DfES/0803/2001) clarifies responsibilities for schools under existing health and safety legislation. With schools that are maintained by LEAs, responsibility for fire safety is usually shared between the authority, the governing body and the head teacher. The LEA usually has responsibility for alarm systems and the structural fire integrity of buildings, while the governing body and the head teacher are responsible for the day-to-day running of the school and the management of all systems including those fore fire safety. Usually the head teacher will be designated the Responsible Person by the governing body.

All three parties must ensure that school premises comply with Regulation 17 of the Education (School Premises) Regulations 1999. This requires that every part of a school building, and of the land provided for a school, shall be such that the safe escape of the occupants in case of fire is reasonably assured. Particular regard is given to:

- the likely rate at which flames will spread across exposed surfaces
- resistance to fire of the structure and of the materials of which the structures are made and their properties; and
- the means of escape in the case of fire.
1.3 EXISTING GUIDANCE

Compliance with the measures in ADB will ensure that there are minimum levels of life safety achieved in the event of fire. ADB provides guidance on means of warning and escape; fire spread within and between buildings; fire fighter access and suitable facilities for fire-fighting. Designers will also need to be aware of the changes arising from the European Commission’s Construction Products Directive 1988 which will have a direct bearing on the reaction-to-fire and fire resistance requirements of materials used in buildings. There is already a European Amendment to ADB published in 2002.

The Department of Education and Skills has a range of Building Bulletins on school design (see Part 10, Bibliography). Many of these make reference to fire safety but it is in this document that both life safety and property protection design issues are brought together and addressed. The Department’s Managing School Facilities Guide 6 Fire Safety covers management issues (see www.teachernet.gov.uk/schoolbuildings ). These are summarised in Part 9. The Schools Guide under the Regulatory Reform Order 2002 will also be useful here.

As school building usage becomes ever more flexible in response to the needs of the local community so a more engineered approach to life safety and property protection will be appropriate. Fire safety engineering is a risk-based approach and should provide a flexible way of solving the design problems and management issues. The fire safety strategy for the building may also include the level of management needed.

1.4 FIRE SAFETY ISSUES

While the prime fire safety issue is that of life safety of the pupils and staff it is sensible to consider other factors which will have a bearing on general fire safety. These will range from the location of the school and the regional area it covers to the use by the local community. Will the buildings be used by all ages in the community or just pupils?

The influence of infrastructure such as roads and the siting of the school with respect to the local fire station will also have a bearing on how rapidly the Fire and Rescue Service can attend the scene and fight the fire. They will base this on their risk assessment and noting that in suburban school locations there may be a ten to fifteen minutes delay before the fire appliance reaches the building.

The provision of appropriate pressure for water supplies, hydrants, or the availability of standing water, rivers or canals may mean the difference between a small fire and a major loss fire. Designers should check with the local water authority to see if there are any problems with the water pressure that may have to be addressed in their design. In certain cases sprinkler systems may be installed

One of the most serious issues that schools can face is the possibility of arson.

![Figure 1 School closed after fire - typical aftermath](Courtesy of Northamptonshire Fire and Rescue Service)
This school was closed for some time after the fire. The LEA will usually have to provide alternative accommodation until the affected part of a school is rebuilt.

ODPM reports that ‘the number of arson attacks has increased steadily over the years. It is now the largest single cause of fires in schools, with 70% classified as deliberate. Recent research by the Association of British Insurers (ABI) and the London Fire and Emergency Planning Authority indicate that as many as one in eight schools nationally suffer some form of arson attack each year. Between 1997 and 2001 there were on average 2,119 serious fires per year in educational establishments in the United Kingdom of which 1,564 per year occurred in schools with a total economic cost of £70m. Expressed as the number of fires per 100,000 population that averages at 1.65 for the UK and 1.62 for England and Wales.’

Received wisdom was that deliberate fires occur when the school is unoccupied so there is a low risk to life apart from those lighting the fires. However, this is now changing with up to a third of fires starting during the school day when the risk to large numbers of pupils can be very high with the younger pupils dependent on teachers and other staff for their safety in the event of fire. Typically, however, the larger fires still occur out of hours when the school is closed and the fire setter can work undisturbed and/or there is a delay in discovery.

Fire safety including arson prevention is now closely tied to security of the buildings and the site. Good security along with good housekeeping will mean there is very little chance of the opportunist fire setter causing damage, see Part 8.8.

As part of the Risk Assessment of all these factors, fire safety measures must also take account of the use of the buildings, whether they are part of the community or not. If there are boarding facilities then there will be a ‘sleeping risk’, which will need careful consideration. Special needs pupils may also need additional facilities, this means that refuge areas/places of temporary safety must be provided.

1.5 RISK ASSESSMENT CYCLE

The final design of the building will present a way of dealing with the risks in a particular school, which have to be addressed during the life of that building. If the initial Risk Assessment is effective, there will be very little to amend during future reviews. This will reduce costs in the long term.

![Fire Triangle](image)

**Figure 2 The Fire Triangle**

The simplest way to represent a fire is by the Fire Triangle which summarises the three elements needed for a fire to develop: namely a fuel which can be ignited by a heat source in the presence of oxygen from the air. Control of the fire is by eliminating one of the three elements. Identifying fire hazards includes recognising the fuel load and whether there are any heat sources present as say in kitchens and laboratories. The five stages in a fire risk assessment are outlined in Figure 3. These five stages are based on the five step approach
in the Home Office *Fire Safety An employer’s guide* (1999). There are other methods but this is the most straightforward.

An example of the parameters that will need to be considered in a Risk Assessment of an escape route in an occupied building may be helpful:

- Is there an alternative means of escape?
- Is the single route out of the building protected by fire resisting construction?
- Is the fire resisting construction compromised, e.g. by doors wedged open, damage to walls etc?
- Is access to the escape route via a cloakroom?
- Are the escape routes of adequate width throughout their length and free from obstructions that could slow egress?
- Are there directional signs for pupils with hearing impairment?
- Is there clear access to an escape route for a pupil with sight impairment or in a wheelchair?
- Is there a safe refuge for them?
- If above the ground floor, are the stairways all accessible at all times?
- Are they wide enough for all the people escaping from the building for its full height?
- Is there a protected stair?

Stage 1 Identify the fire hazards

Stage 2 Identify people at risk

Stage 3 Remove or reduce the risk where possible

Stage 4 Are the fire safety arrangements satisfactory? Record findings and detail any actions

From the output of the assessment:

- Carry out any improvements needed
- Prepare or amend a fire action plan

Stage 5 Review and revise the assessment regularly

Figure 3 The five stages in the cycle of a fire risk assessment

**2 ANALYSIS OF THE PROBLEM**

Part 2 provides the basis for understanding why fires develop and spread and how smoke moves through the building. It then outlines how to minimise the growth and spread of the fire thus allowing pupils and staff to leave safely. It is important that schools are designed to reduce fire spread bearing in mind the costs involved and the need for flexibility of use.
Formal requirements for life safety are covered by national legislation and supporting technical guidance with respect to fire. These do not cover property protection with the same rigour as do the insurer’s recommendations but do include the consideration of the life cycle of the building. Now schools have greater autonomy, part of the individual running costs will always be for insurance against damage to the buildings especially from fire; further the continuity of service to the community in terms of educational needs may have to be regularly updated. Where arson is a regular problem the premiums will reflect the risk and will be correspondingly high. It is the intention of this guidance to address both the life safety needs and the property protection needs at the same time. This holistic approach will allow designers to tailor their strategy to the location, use and risks identified. Note that while the designers will be responding to a societal or community perceived risk, the insurer will define a much more specific risk. Note, too, that many insurers will be providing a general service through the local education authority (LEA) and may not alter premiums to reflect installations such as sprinklers.

2.1 Fire development and spread
2.2 Smoke movement and its impact on escape
2.3 Containment and restriction of the growth of the fire
2.4 Site planning
2.5 Use of the buildings
2.6 Role of the staff.

2.1 FIRE DEVELOPMENT AND SPREAD

While the risk of fire can be regarded as being low in many assembly buildings such as theatres and cinemas, it is regarded as a challenge by the younger opportunist arsonist in and near a school building. Corridors and circulation routes might also be considered as low risk but put school lockers, display boards and pupils together and the risk can easily increase. Note, too that in some schools, circulation areas can be opened up to allow flexible meeting and/or teaching areas where they will present a risk. The greatest opportunities for arson will be in cloakroom areas that open off circulation routes. Approved Document M (ADM) recognises that corridors may need to include lockers; these should be non-combustible.

Open cloaks areas should not be permitted off protected corridors or off staircases, nor should an inner room be accessed via a cloakroom. Any lockers should be non-combustible.
The greatest probability of an accident leading to a fire will be in ‘hot work’ areas such as kitchens, laboratories and workshops, with service installations being another area to consider. Where there is gas piped into laboratories there can also be a risk of hidden fire spread. It is also worth noting that there can be a lot of fuel present in schools which are well supplied with Information and Communications Technology (ICT) equipment and have the cabling hidden in the ceiling or in under floor cavities.

Existing guidance suggests that one should ‘attempt to identify the positions of all possible sources of outbreak of fire and to predict the courses that might be followed by a fire as it develops, or, more particularly, the routes that smoke and hot gases are likely to take, including concealed spaces.’ The guidance within this document addresses this in the specific context of schools, see Parts 4 and 6.

In the case of arson this is more difficult as much of the arson will be opportunistic and therefore whilst the removal of likely fuel, rubbish, etc will reduce the possibility of an ignition occurring, not even the best design will counter the efforts of the really determined arsonist. But there are several strategies for making their efforts less effective. See DfEE Managing School Facilities Series Guides on Security (No 4) and Fire Safety (No 6) which taken together will eliminate many incidents as access to the buildings will be controlled with good security.

Choice of materials for room linings and furnishings will all have a bearing on the possible spread of fire once an item has been ignited. When the fire starts in an enclosed space, hot smoke- laden gases will rise to the ceiling and form a layer which will flow under the whole ceiling at first and if not controlled it will then deepen and eventually fill the whole space. This is known as ‘smoke-logging’. As the fire grows in area flames and radiated heat will spread to any combustible materials such as fittings, furniture exposed papers etc. The flames will grow in length, increasing in height until they reach the ceiling where they will be deflected horizontally. Heat will then be radiated downwards which accelerates the growth of the fire as other items become involved in the fire. If there is little fresh air getting into the space the rate of fire development will slow as there is less oxygen present to keep the fire going. The gases generated will be very toxic and high in carbon monoxide.

When the materials involved in the fire are rich in carbon as in plastics materials, the rate of fire growth is likely to be rapid with high temperatures reached and copious quantities of dark smoke being produced. This smoke will be irritant, disorienting and will cause coughing and streaming eyes which will make moving away from the area difficult. The radiation from the flames once they reach the ceiling will be high, further promoting fire growth.

If the enclosing structures round the area of fire origin have no fire resistance and are poorly sealed especially at the joints with floor and ceiling, then the ceiling itself will be penetrated by the fire and spread into the adjoining space. Even with fire-resisting constructions, the pressures developed by the hot gases as they expand and become more buoyant may generate spread into other areas such as stairwells, lift wells or ducts. As the hot gases move through these vertical shafts they may reach other floors through any openings in the shaft. If there is sufficient airflow into the shaft then it can act as a chimney and will accelerate the growth of the fire.

So, a fire starting in a compartment in a building may not only put anyone present in the room of origin at risk from the effects of the combustion products but if uncontrolled it will spread to other parts of the building as well. This could jeopardise the safety of people remote from where the fire started and could also cause damage over a wide area. Thus schools should be designed to reduce fire spread. All the contributory factors to safe egress must be in place and functioning. These factors are good design, suitable choice of materials, well-trained staff; functioning emergency equipment including detectors, passive and active systems and ventilation systems.
2.2 SMOKE MOVEMENT AND ITS IMPACT ON ESCAPE

Early on in the fire, the most critical effects on the occupants will be from the smoke and other products of combustion. Smoke is often the first thing to be noticed by the occupants and is generally the cause of the first alarm. In the absence of any strong air currents smoke tends to gather at ceiling level, filling the space from the top down. Once down to head height people will not be able to see very far because of the density of the smoke and the unpleasant effect on their eyes. Breathing will be difficult, as the carbon monoxide levels increase so the breathing rate goes up and more smoke is taken in which will be increasingly short of oxygen. The effects will be felt very quickly by younger pupils, who breathe quite rapidly anyway. They will eventually lead to asphyxiation because of the lack of oxygen and because the smoke is hot.

Recognition of these circumstances is essential when dealing with different age groups who may be familiar with the building but may not be very mobile for a variety of reasons. Legislative controls are usually cast with adults in mind. Although compliance can be achieved for adult occupants, designers and users of school buildings do need to consider the younger, smaller and shorter pupils at the planning stage to allow everyone, regardless of age, size and disability to leave safely.

It is important, therefore, that the escape routes must be protected against smoke penetration and the storey or final exit must be reached before they become untenable. The time taken will need to take account of such things as the furniture present and the size of exits and the age and mobility of the occupants.

Early warning of smoke being present and if possible, a means to ventilate it will aid effective means of escape before the Fire and Rescue Service arrive. The time for the presence of the smoke causing life-threatening conditions may be very short. Thus all the right measures must be in place to allow safe egress. Apart from recognising the role of smoke control doors existing guidance has not specifically targeted the control of smoke. In addition to the threat to life safety described above, smoke will contaminate sensitive ICT equipment as well as books. Hence this guide highlights how smoke containment may be improved in schools in addition to the normal measures introduced for fire containment.

2.3 CONTAINMENT AND RESTRICTION OF THE GROWTH OF THE FIRE

Constructions capable of resisting fire and restricting the spread of smoke are used throughout schools for:

- providing protected routes to final exit points from a building (more common in multi-storey schools)
- providing refuges on all staircases in case there are wheelchair users (ADM)
- isolating special risks
- limiting the areas involved in a fire eg by compartmentation.

Life safety will be enhanced and property damage will be reduced if improved smoke tightness can be incorporated even in the elements used for the construction of the cellular layout required for the primary purpose of teaching. The extent to which fire resisting and smoke resisting constructions are introduced will depend upon the layout and location of the element concerned. Note too that the recent changes with respect to Acoustics in school buildings will also have an impact, see BB93. The use of open plan areas with screens is deprecated in favour of ‘a generous range of spaces in a variety of sizes to give far more opportunities in teaching.’ The choice of lining materials chosen for acoustic reasons will also have a resistance to ignition and a rate of fire growth which are reasonable in the circumstances. The extent to which this is necessary will depend on the location of the lining.
To allow pupils and staff ease of movement through the building, designers may opt for hold open devices on doors. Provided these are linked to the automatic fire detection and alarm system (AFD) so they close in the event of a fire the compartmentation of the building will be maintained, see Part 8.1. Some doors in existing buildings may need closing manually – this will need to be part of the fire safety management procedure for staff.

Risk assessment will be important in defining how and where fire resisting and smoke tight elements are incorporated and where linings are controlled.

Internal subdivisions may be the first choice but with larger shared spaces becoming more popular, designers must take the implications of these on board. Similarly large undivided spaces for sports and other activities may exceed maximum compartment sizes specified in the guidance in support of regulations (currently 800 sq m unless compensatory features such as fire suppression are installed then the size can be increased to 2000 sq m). Suitable measures can be employed to mitigate against the risks this presents, see Parts 3, 4, 6, 7 and 8.

Ancillary areas must be considered and are dealt with in detail in Part 6. It is obviously good practice to site boiler rooms at a safe distance from the occupied buildings. Rubbish containers should be stored in locked areas well away from the buildings, school entrances and exits. The Arson Prevention Bureau reports that the majority of school fires still occur around 11.00pm; if access to school buildings is not restricted this will remain a valid statistic.

2.4 SITE PLANNING

School sites may be green field or may be severely restricted by their urban setting. The possibility of fire spread to and from adjacent buildings becomes a likely outcome of a growing fire. There is technical guidance (in ADB – B5) on building separation distances along with sufficient access for fire appliances(ADB – B4) and these form part of the controlling measures. Site planning must also consider the location of the building and where final exits may lead and whether there is sufficient space for all the occupants of a school to gather safely outside. The designers should consult with planning officers, fire officers and building control bodies to ensure adequate provision is made for access by the Fire and Rescue Service as well as for the safe assembly of the school occupants.

2.5 USE OF THE BUILDINGS

With the increasing use of school buildings for community, or part-time use throughout the day and evening, the designer will need to cater for extended use very carefully, particularly for a refurbishment scheme. The major impact of the extended use is that the occupants of the building during this period are less familiar with the layout and facilities than the daytime pupils are. As a consequence the escape plans and provisions must accommodate this change in occupancy even down to whether designated assembly points are adequate even with the likely increase in car parking which might mean loss of the previous grassy area for assembly. Thus extended use will probably require the provision of:

- increased lighting, especially emergency lighting and external lighting
- changes in evacuation planning and operation
- increased car parking
- changes in door hardware selection.

The daytime use of the majority of school buildings presents a range of risks but where there is residential accommodation for school pupils and/or staff as part of the main school building or as a totally separate building there is an added sleeping risk. Pupils and staff will need to roused before they can leave the building if a fire occurs. The accommodation may take the
form of individual study/bedrooms or dormitory type accommodation, with or without cubicles. Individual or communal kitchen/dining facilities may also be included.

Whatever the case the same principles of design should be applied to ensure pupils and staff should be able to escape safely in the event of a fire and any fire spread within the building should be limited by good construction. In some circumstances a combination of physical construction and active fire suppression measures e.g. the use of automatic sprinklers may be appropriate. The findings of the recent BRE Project Report on the Effectiveness of sprinklers in residential premises indicate that residential sprinklers are generally not cost-effective for life safety. However they can be cost effective if the installation and maintenance costs are minimal and there are the additional benefits of reductions in injury and property loss.

Escape routes from different areas of use must be carefully planned following a risk assessment taking account of designed or existing facilities for means of escape. Escape from indoor swimming pools and games areas will need to allow for possible egress in cold weather as well as day and night-time conditions. Although not a requirement, the designer may need to consider that infants will need much shorter distances to a place of safety than their secondary school colleagues as published guidance is tailored to the able-bodied adult. The use of only part of the building for community use (where alternative evacuation routes may be locked for school security reasons) along with the need to training a Responsible Person for day and evening activity is also an issue that needs to be identified.

Good design will result from weighing up the risks presented and providing the necessary automatic fire detection, alarm system and fire suppression and smoke control systems if necessary. The BASA (British Automatic Sprinkler Association) code of practice for sprinkler systems in schools could be helpful here.

2.6 ROLE OF THE STAFF/MANAGEMENT PRINCIPLES

Staff involvement in the safety of both the building and its occupants has a major role and is summarised in DfES Guidance on Organisation and Management arising from the Management of Health and Safety at Work Regulations. Staff need to be familiar with escape routes and safe locations for the pupils in emergencies. Regular fire drills with full evacuations are essential and must take place on normal school days not just in summer when the pupils are relaxed, revising or studying at home. Practical experience of how to shut down and leave laboratories/kitchens/workshops safely will be an important element in the exercises, see Part 9.

3 PLANNING FOR ESCAPE

If schools are to remain flexible and allow pupils of all ages to take advantage of new ways of learning it is unlikely that there can be a master plan that will survive all the changes. Should there be an emergency such as a fire, all the occupants must be able to reach a place of safety without delay. There shall be sufficient exit routes and doors to allow everyone to get to the final exit and then away from the building. Even in places where there are large numbers present, the design shall enable the whole building to be evacuated.

The design of the escape routes will depend on the complexity of the layout of the building, how large it is, how many floors there are, and not least, the mobility of the occupants. There shall therefore be some scope for places of refuge and phased evacuations to be part of the planning. Phasing an evacuation allows parts of the school to be cleared of occupants before other areas remote from the fire. Guidance in support of regulations (ADB) is very clear that the design shall also be based on assessment of the risk to the occupants should a fire occur.
Successful escape from the buildings will depend on other factors as well as planning. These will include the provision of emergency lighting, signage, correct door hardware, early warning as well as training and management.

The requirements of the Building Regulations are given below. Designers also need to be aware that for Building Regulations applications there is a requirement for consultation between the enforcing bodies as contained in the Building Act 1984, the Fire Precautions Act 1971 and the Fire Precautions (Workplace) Regulations 1997 (as amended); guidance on this is given in Building Regulations and Fire Safety – Procedural Guidance revised in 2001. However, the Fire Precautions Act 1971 does not apply as schools are not designated under the Act. But there may be occasions in the design of an Extended School where a separate building or part of a building would need to be certificated, for example office provision for Schools Inspectors. The rest of this section outlines the careful attention needed when planning for the safe evacuation of the building in the event of fire.

3.1 The requirement
3.2 Circulation, access and escape routes

3.1 THE REQUIREMENTS OF THE BUILDING REGULATIONS

The Requirement in Part B of Schedule 1 to the Building Regulations 2000 (as amended) states that: ‘The building shall be designed and constructed so that there are appropriate provisions for the early warning of fire, and appropriate means of escape in case of fire, from the building to a place of safety outside the building capable of being safely and effectively used at all material times’.

3.2 CIRCULATION, ACCESS AND ESCAPE ROUTES

It is imperative that the planning of circulation routes, access routes and means of escape should take place very early in the design phase. There should be a clear strategy for all levels of access to the buildings as well as local circulation between spaces. Where possible all escape routes should mirror the everyday circulation patterns within the building. This avoids providing alternative means of escape that are only used in an emergency. This will ensure that all the pupils, especially the youngest ones, are already familiar with how to leave the school quickly and will minimise their anxiety in an emergency particularly while the fire alarms are sounding. While alternative protected routes are an option, such a provision will be costly and may be a waste of space unless the occupants are familiar with them.

Figure 5 Note this corridor contains display boards with covers so there is no loose material. Fire extinguisher clearly visible.

In ‘Schools for the future’ BB95 points out that as school buildings are used by large numbers of people other than pupils and staff who are unfamiliar with the layout then the architecture as well as the signage should indicate access and egress provisions. During the early phases of the design, account will be taken of this intended use. Will there be a single entry point, good for security; or will there be separate entries relating to the type of user, are they
pre-school infants, school pupils, business or community users? It is at this stage that future congestion of routes can be avoided.

For all schools it will be important to include the needs of special needs pupils who may not be sighted or able to hear warnings. Adults may come in for language classes for whom English is not the first language. Designers need to be aware of how to indicate a route not only by signs but by changes in colours and textures on walls and floors. Where mobility is a problem a place of safety/refuge will need to be provided (BS5588: Part 8) until the person can be escorted out of the building. Circulation routes can overlap with social or study space. This is now a fairly common feature in the two-classroom modular approach where there is a through route at the rear of the classrooms which includes additional space for ICT or quiet study. This circulation route will also become the escape route in the event of fire.

Circulation areas are identified in regulatory guidance as possible routes for the fire to spread through the building. Thus care in the choice of materials for lining and furnishings must be taken.

Although single staircases are allowed in new buildings where there are no more than 120 pupils plus staff there should be a maximum travel distance of 18m (see Table A1), a protected corridor and stair which does not lead to a basement. Note that the use of basements for teaching accommodation should be avoided unless the site is restricted vertically. The single escape stair should be provided with a fire resisting lobby or approached through a fire resisting corridor at all storeys. Open cloaks areas must never be part of a single stair provision, nor should they be allowed on the circulation route leading directly from it. Ideally, at least two protected stairways should be included to provide for vertical escape from a multi-storey building. In some larger schools the stairs may have to become fire-fighting stairs for the Fire and Rescue Service.

During a refurbishment it may be possible to upgrade existing second staircases by ensuring that the linings of existing stairs are of limited combustibility or Euroclass B- s3, d2 or better.

The requirements of M1/M2 of Schedule 1 of the Building Regulations are satisfied by Approved Document M (ADM) Access and facilities for disabled people. A passenger lift is the most suitable form of access for people moving from one storey to another. In exceptional circumstances in an existing building a wheelchair lifting platform can be considered provided it does not compromise the existing means of escape. In any case the merits of the design choices will need to be argued in the Access Statement. There should also be a suitable means of access provided from the lift to the remainder of the storey. ADM gives details of minimum lift dimensions ie 1100mm wide and 1400mm deep. Any alternatives for smaller buildings can be achieved by management plans for means of escape for disabled pupils and staff and presented in the Access Statement. It may be beneficial to treat all lifts as evacuation lifts which will allow the safe escape of anyone with a mobility problem. See also Part 7.4.

Emergency lighting has not usually been provided on escape route except from public areas as pupils are generally regarded as being familiar with buildings and it has rarely been dark when pupils are present. However, where both parents are working some schools allow early attendance / homework clubs, there will be altered attendance patterns. It is then likely that in the winter months especially, there will be quite long parts of the school day in darkness which along with the possibility of power cuts means that it is preferable to provide emergency lighting throughout the building. Indeed, with greater Community use, schools need to provide out of hours lighting for members of the public, see Parts 7.2 and 8.2 for more detail.

Security needs and the need for privacy for say examinations will mean that some rooms should not be on a thoroughfare that is constantly passed by groups of pupils. Zoning may be the way to treat those areas that get the greatest use during and after school hours which will also allow for better security and services. Where flexibility of use is sought, it should be recognised that simplicity is the key. BB95 points out ‘for some designers this might conflict with efforts to achieve visual excitement through complexity’.
Further details on planning the escape routes are given in Appendix A which summarises the Building Regulations guidance. This is provided for those designers who are reticent about achieving compliance using the fire safety engineering approach based on risk assessment.
PART 4 RESTRICTING THE SPREAD OF FIRE THROUGHOUT THE SCHOOL

This section looks at how the design of the construction can assist in limiting the spread of fire and smoke through the choice of materials and understanding how they can best be used. There are a number of ways that the designer can reduce the effects of a fire using passive fire protection eg by:

- limiting the use of easily ignited materials
- using fire resisting constructions (load-bearing and non-load-bearing)
- using smoke restricting constructions
- limiting the likely spread of flames and smoke production
- preventing fire and smoke exploiting cavities
- preventing fire from exploiting services or ventilation ductwork
- limiting the potential for spread of fire to an adjacent building.

Common sense will dictate some choices of material, eg flammable/slipping floor coverings in a laboratory would not be successful for everyday use let alone in the event of an emergency such as a fire. The designer and specifier of materials must be aware of the changes in the appropriate test methods following the Construction Products Directive 89/1076/EEC. The Commission Decision 2000/367/EC of 3 May 2000 refers to the classification of products to the resistance to fire tests and 2000/147/EC of 8 February 2000 refers to the classification of products to the reaction-to-fire tests.

With the emphasis on new build, extensions and refurbishments that allow greater flexibility of use, the simple option of building a series of fire-tight boxes in the school buildings is considerably reduced. However, with respect to the acoustic requirements of the building to provide “suitable indoor ambient noise levels for clear communication of speech between teacher and pupil, between pupils and for study activities” (as dealt with in ADE and BB93) these should result in fire-tight enclosures within the overall design. The distribution of barriers to restrict fire spread will involve a greater degree of thought and recognition of the risks posed by the layout to the users and the occupants. A balance will need to be struck between the everyday needs in the building and security and fire safety.

Fire resisting and smoke restricting construction has three primary objectives:

- to prevent fire from spreading into protected routes ie protected corridors and stairways
- to isolate area where the risk assessment has identified hazardous areas or areas identified as critical to the functioning of the school
- to restrict disproportionate damage to the school as a result of a fire by means of compartmentation

This section will outline specific guidance and then go on to cover how to protect escape routes, key facilities, isolation of hazards and how to restrict disproportionate damage. This is followed by guidance on robust construction, glazed components; fire doors and their hardware; how to identify and seal linear gaps, protection of ductwork and choice of materials for effective linings.

4.1 Slowing the growth and subsequent spread of fire
4.2 Containing the fire by means of the construction
4.3 Preventing fire spread between buildings

4.1 SLOWING THE GROWTH AND SUBSEQUENT SPREAD OF FIRE

The contents of a school are invariably combustible and whilst the school can use soft furnishings that are combustion modified in accordance with the guidance given in BS7176: 1995, the raw materials of learning, i.e. paper, books and increasingly computers, are
inevitably going to be combustible. Equally, little control can be exercised over the combustibility of material brought in by the pupils, whether in the form of clothing, bags, games or hobby equipment etc. As a consequence, fire will always be a probability in schools, but the structure should be of a standard that does not encourage a small fire to grow into a big fire in an unacceptably short time. Consequently certain restrictions will be imposed on the materials of construction to ensure that this is the case. These restrictions will be expressed as the reaction to fire properties of the materials and are outlined below.

Since 1 March 2003, with the introduction of ADB Amendments 2002, the regulatory guidance is now given in terms of performance in relation to British or European Standards for methods of test or in terms of European Technical Approvals. UKAS accredited or notified laboratories can conduct the relevant tests and suitably qualified fire safety engineers will have the necessary expertise to advise designers. British Standards can be used until replaced by the relevant new European Standards. Fire-resisting elements should conform to an appropriate specification such as that given in Part II of the BRE Report Guidelines for the construction of fire-resisting structural elements (BR 128, BRE 1988) or be designed in accordance with the relevant British Standard or the equivalent European Standards.

The factors to consider in relation to specifying the duration of fire resistance periods are

- fire severity
- building height
- building occupancy

The likely fire severity is generated in very broad terms from the use of the building. In the case of schools in Building Regulations guidance, this is defined as ‘assembly and recreation’ on the assumption that the building contents (fire load) are similar. Any areas used for residential purposes will be classed as ‘residential’.

The specified fire resistance periods, see Appendix B, depend on:

- the fire load density – the amount of combustibles per unit floor area
- the height of the top floor above ground – the maximum is 30m unless sprinklers are used. This has a bearing on the ease of escape, fire-fighting and whether there is a possibility of collapse
- the occupancy, which will affect how quickly the building can be evacuated
- whether there are basements
- whether the building is single storey when it is expected that everyone will have left safely before any collapse can occur.

The new European-based guidance recognises that ‘because the use of buildings may change, a precise estimate of fire severity based on the fire load (in a school) may be misleading. Therefore, if a fire engineering approach is adopted the likelihood that the fire load may change in the future needs to be considered’. Thus the guidance accepts that building use is very likely to be flexible and will respond to the changing needs of the occupants. Therefore it is important to have a clear fire strategy report on site, which incorporates the management principles of the building with respect to fire.

**4.2 CONTAINING THE FIRE BY MEANS OF THE CONSTRUCTION**

If a fire breaks out, grows and fully involves a part of the structure, then the fully developed fire should not inhibit the use of dedicated, protected escape routes. Such routes are protected by constructions that are able to satisfy the appropriate criteria of the fire resistance test. Other elements of the structure may be required to provide fire resistance for the purpose of:

- reducing the area of the building that is at risk, in line with regulatory recommendations;
- protecting against disproportion damage to the facility in the event of a fire;
- containing areas of high risk;
• protecting areas that are critical to the running of the school, or have a high intrinsic value.

In each of these cases the construction shall satisfy the relevant criteria (REI) of the fire resistance test, see Appendix B.

When a building is constructed to prevent the spread of fire from another part of the same building or an adjoining building, it is said to be compartmented. The compartments may consist of single or multiple rooms, spaces or storeys. The compartment should be constructed so that their relevant boundaries are fire-resisting. The results of poor subdivision may not be obvious until there has been a fire, see Figure 6.

Previous guidance in the Department of Education and Science’s Building Bulletin 7 ‘Fire and the design of education buildings’, VI edition 1988 (BB7) stressed the importance of mainly cellular room layouts in order to contain any fires. Whilst this remains valid, fire safety can be achieved to a similar level by utilising larger, more open spaces although that puts a greater onus on the remaining elements to perform well in the event of fire. This means that durability in service and resistance to abuse is more critical and must be considered when specifying in such areas of constructional weaknesses as junctions of wall – wall, wall – ceiling etc. Similarly experience has shown that the quality of workmanship is crucial in the construction of buildings. Some sectors of the construction industry are now providing Codes of Good Practice to guide the people working on a site, these should be referred to as necessary.

Much of this approach to the design of the building is highly relevant to existing buildings. But for new buildings and extensions it may be beneficial to consider the function of the space for everyday use, what risks it represents in terms of fire and general safety and how to reduce those risks without compromising the use. This is expanded more fully in Appendix C together with the necessity to consider the need to protect the building against disproportionate damage in the event of fire with robust constructions. The Appendix includes a summary of robust materials that can be used for fire separating walls and floors to withstand mechanical damage and reduce the effects of a fire.

4.3 PREVENTING FIRE SPREAD BETWEEN BUILDINGS ON THE SCHOOL SITE

If a fire starts outside a building or breaks out of a building there is a danger that it might spread to adjacent buildings. For this reason regulatory guidance limits the use of roof coverings which will not give adequate protection against the spread of fire over them near a boundary. It also limits the number of openings in the external wall relative to the location of the boundary. This approach should limit fire re-entering the building or spreading to another one.
A school roof should not be part of an escape route. Nor should there be access to the roof of a new building as uncontrolled access to the buildings may result in damage from vandalism including fire.

PART 5 VARYING THE PROVISION BY THE USE OF FIRE SAFETY ENGINEERING

Building designers have had a choice of approach since 1985, when Building Regulations moved away from being prescriptive to being functional. At the same time it was recognised that simply complying with guidance did not always fulfil the perceived needs of novel designs. Hence the guidance allows the alternative approach of fire safety engineering which addresses design issues in terms of risk assessment with particular emphasis on the need for effective means of escape of the occupants in the event of fire. The engineered strategy ensures that there are places of safety within the building that can be reached quickly and that the time taken to get out of the building is as short as possible in relation to the number of people present. The lowest numbers in a new primary school will be 210 pupils made up of a Single Form of Entry for infants of 90 pupils plus staff and 120 pupils for a Junior School.

As in regulatory guidance, fire safety engineering also addresses structural fire resistance, compartmentation, specification of materials for their fire performance, measures to avoid the spread of fire within and between buildings and to provide suitable access for the fire service to fight the fire. However fire safety engineering strategies would not be applicable to cosmetic changes and additions to school buildings but would if there were a major refurbishment that included novel designs reflecting the need to change say to an inclusive school. The inclusion could be for pupils with some form of disability or it could be to convert to an Academy providing for all ages from 3-19 years. The premise for the design is that of identifying the hazards present and thus defining the risk and designing against that risk in order to reduce or negate its affect.

Prescriptive guidance provides a minimum level of safety for different occupancies and is conservative in approach. School buildings come within the assembly and recreation occupancy group which embraces a widely differing group of buildings. The advantage of the fire safety engineering approach is that it is tailored to the specific building and need not be so conservative. Billington et al in their book Means of escape from fire, warn against tailoring a design too closely to the minimum performance as buildings change over time and the fire strategy may have to be adapted as a result. Indeed the basic design process should involve the fire safety engineer at as early a stage as possible to eliminate any discrepancies arising out of the need to incorporate design solutions against the assessed fire risk.

5.1 Qualitative Design Review (QDR) process - for the whole design team
5.2 Quantified analysis of design
5. 3 Acceptance criteria

5.1 QUALITATIVE DESIGN REVIEW (QDR) PROCESS

For the fire safety engineer to be an effective member of the design team from the start there is a two-way process of understanding that needs to be set up to cover:

- the function of the building and likely future developments of the site
- likely numbers of pupils related to type and age range of school and staff
- familiarity and mobility of the regular occupants
- how might means of escape be enhanced by the number of stairways, exit locations and an understanding of how the staff will be able to control the evacuation
- circulation patterns
- access for the Fire and Rescue Service, note that a typical appliance will occupy a space of about 6 x 3 x 3m
- size of the spaces within the building(s)
- location of fire hazards and fire loading ie a design fire scenario
likely management systems
• anything unusual about the structure
• environmental impact from the potential fire especially from any ventilation systems
• impact on the continuity of the 'business' of the school
• the implications on the life cycle of the school building(s)

BS7974\(^1\) describes this QDR process which should be done early on so that any substantial findings will inform the design before the construction drawings are prepared. QDR should become a routine that is considered at every change in the design, i.e., an iterative process that is repeated as the design moves from broad outline to the detail. Note that the needs of CDM must not be ignored in favour of this process – both will apply.

BS7974\(^1\) defines the steps to be taken as:

- review the architectural design of the building including the layout and geometry, construction details, loading on the structure and fire loading
- establish the fire safety objectives for the life of the building which will be life safety for both occupants and fire fighters; minimize the damage to the property as well as adjacent buildings and limit the release of toxic materials
- identify the fire hazards such as ignition sources, combustible contents, the nature and activities in the building and then the likely consequences
- establish trial fire safety designs (fire protection strategies) this allows the quantification stage to proceed. A checklist for these trials is given below
- identify acceptance criteria
- establish fire scenarios for analysis

The check list for the development of trial design is the same for any building and can easily be applied to schools. The areas covered are:

- automatic suppression (if necessary)
- compartmentation
- automatic systems
- smoke control
- alarm and warning systems
- evacuation strategy
- means of escape
- first-aid fire fighting
- Fire and Rescue Service facilities
- management of fire safety

5.2 ACCEPTANCE CRITERIA

Whatever measures are taken to reduce the effects of a fire, injury and death there is always a possibility that a fire will occur with its resultant consequences. Therefore the adequacy of the design must be judged against realistic criteria by using one or more deterministic or probabilistic (risk-based) methods, comparative or financial criteria.

For deterministic studies the QDR should establish a worst case fire scenario and recognize that any uncertainty in the calculations or if the design clearly fails, should be considered. It is better to err on the side of safety if there are any doubts. For probabilistic studies the aim is to establish that the likelihood of a given event is acceptably small (PD 7974-1); note that society at large does not consider a large loss of life from one incident like a bus crash acceptable compared with car accidents.

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\(^1\) Note that 7974 is still being developed, the parts are Published Documents (PDs) which may be amended in the future before becoming full British Standards
For comparative studies the designer may decide to accept compliance with current guidance as in the BS 5588 series where alternative solutions and/or alternative measures are allowed. An example would be the installation of sprinklers allowing an ‘oversized’ space, more than 800sq m to be designed and built should a school have need of such a space.

A cost-benefit analysis to assess the value of additional fire protection measures against the effects of fire and smoke can be used as the financial criteria.

If at this stage the QDR shows a level of safety in the proposed school design that is equal to the prescriptive codes and guidance there may be no need for any further analysis. In some circumstances full probabilistic study may not be necessary as there is sufficient information from fire tests to arrive at an acceptable judgment. However if there is a very radical design then PD 7974-0 and subsequent parts will apply.

Fire scenarios must be based in reality, reflecting conditions in the proposed or existing school and its environs. If there are problems with vandalism in the area that will mean a much more pro-active approach to security, as well as for the selection of materials that will reduce fire spread. The QDR team should choose a range of scenarios that do and do not require analysing. For example a school without a canteen will not need to consider kitchen fires other than those that might occur in food technology areas.

5.3 QUANTIFIED ANALYSIS OF THE DESIGN

After the QDR a quantitative analysis should follow with the analysis split into six areas, each are dealt with separately in the six parts of BS PD 7974. These are termed sub-systems and are

1. initiation and development of fire within the enclosure of origin
2. spread of smoke and toxic gases within and beyond the enclosure of origin
3. fire spread beyond the enclosure of origin
4. detection and activation of fire protection systems
5. Fire and Rescue Service intervention
6. evacuation.

The design assumptions are generally conservative and they should link together in the design process. Their interactions are shown in an information matrix. Each sub-system can be quantified by deterministic studies or by probabilistic risk assessment. In practice it will usually be an amalgam of the two. The standard does offer an alternative which is to ‘treat a fire as a series of random events and assess the possible outcome in a probabilistic manner in order to estimate the likelihood of a particular unwanted event occurring’.

The results should then be compared with the acceptance criteria identified in the QDR and then repeated until a fire strategy has been found that does satisfy the acceptance criteria and any other design requirements. There is an onus on the fire safety engineer to show that the proposed solution will be at least as effective as the conventional approach.

In a deterministic study all those present in the building should leave it without assistance unless disabled, see 3.2 above. This will depend on tenability ie visibility, toxic gases present, heat and structural failure. The QDR should determine which of these poses the greatest threat; in most cases it is the loss of visibility and its affect on ASET (available safe egress time) that is the initial threat to life.

Once all the criteria have been evaluated it may still be necessary for the design engineer to make a professional judgment as well as those responsible for approving the solution as the avoidance of disproportionate damage should be a key criterion within the QDR as well as that for life safety. This is because it is not yet possible to quantify all the levels of uncertainty for all stages of the design process. Most designers of buildings and building components never have or will experience a fire in a project in which they have been involved.
Start

Qualitative design review (QDR)

Quantitative analysis of the design

Assessment against criteria → Unsatisfactory

Satisfactory

Presentation of results

End

Figure 7 Simplified flow chart of the process involved in fire safety engineering

Quote from Billington, Ferguson and Copping

‘At present, fire safety engineering operates in the same context as the prescriptive fire codes. It is therefore often judged against those codes, even though the technical basis for the prescribed solutions may be less robust than the fire engineering principles. While that situation continues there will be problems of acceptance of fire engineered solutions that are matters of perception rather than of technical debate. This acts as a brake on the development of fire safety engineering. But it also forces the engineers to be more careful with the development of their proposals. This must be good for the long term improvement of the state of the art.

The development of fire safety specialists within the design team is another potential contributor to the de-skilling of architects. This applies to fully fledged chartered fire safety engineers as well as to other consultants. The best results are achieved where the specialist augments the architect’s range of skills. If architects were simply to hand over responsibility for fire safety to others, the quality of the design would be bound to be affected.

Fire safety has a major effect on the form of buildings. The architect should control that effect and balance it against all the other competing factors to get the best possible result. It may not be the best result in the fire safety engineer’s eyes (though we naturally hope that it is), but it only has to be good. When the job is over, even the fire engineers get a bigger kick out of the architecture than they do out of a sprinkler system.’
PART 6 ANCILLARY ACCOMMODATION

Under Building Regulations school buildings are described as belonging to the occupancy group ‘Assembly and Recreation’. But the role of ancillary buildings ie those that belong to a different purpose group in their own right can be a potential cause of difficulty for the designer. While school buildings are primarily designed for uses associated with teaching there are buildings and areas within a school site that are by their very nature ancillary to teaching. Residential accommodation may be provided for staff and pupils which plainly belongs to the ‘Residential (institutional)’ group. While laboratories and workshops might be regarded as ‘Industrial’ their role within the teaching environment is clear. Kitchens and storage areas are dealt with under the 1999 Education Regulations, see below.

It is essential that the designer considers the possible risk that one part of the school buildings complex may present to the rest of the school. No guidance can be comprehensive in its detail and the designer must bring an intelligent appreciation of the principles involved before deciding which special measures may be necessary to reduce the risk of fire.

The Education (School Premises) Regulations 1999 lists appropriate ancillary facilities, in particular –
(a) for the storing and drying of pupil’s outdoor clothing and for the storing of their other belongings; and
(b) for the preparation or serving of food and drinks and the washing of crockery and other utensils.

This section deals with areas needing special consideration as they may either be High Hazard ie the source of ‘hot’ activities thus contributing to a high risk area or may represent a valuable resource that is difficult to replace.

6.1 Laboratories
6.2 Design and Technology areas
6.3 Data processing areas, includes ITC resource and teaching areas
6.4 Storage areas including cloakrooms (open and closed)
6.5 Kitchens
6.6 Residential accommodation
6.7 Boiler houses
6.8 Temporary accommodation
6.9 Licenses

6.1 LABORATORIES

The first consideration here will be what ages will be using the laboratories. Mostly it will be pupils aged eleven and above but where the school caters for three year olds upwards as well, additional measures may need to be taken. Middle schools with pupils of 9-13 will also have science laboratories. Much of the guidance in BB88 Fume cupboards in schools will be relevant as this document defines which laboratory areas will need fume cupboards based on the educational needs of the National Curriculum Science up to GCSE.

BB88 recommends that the siting of a fume cupboard should be considered at an early stage in the design of the laboratory based on the need to be used for class demonstrations; mobile or fixed into the laboratory. While it lists several detailed requirements it points out that ‘it is seldom possible to meet all the requirements suggested…‘Compromise is often necessary.’ There is very practical advice too, when in a preparation room the fume cupboard can be placed close to a bench as it will not be used for demonstration purposes and so need not have space and visibility from three sides’. Compromise is also possible if it can only be sited close to a door, then draughts can be reduced by fitting an air transfer grille and a suitable door closer. BS 7258 (Parts 1-4) addresses the installation and running of fume cupboards in laboratories, as well as minimum distances from windows, doors etc to avoid disturbance to
the operation of the fume cupboard. However, more and more fume cupboards are tending to be mobile because of the changes in the way the curriculum is delivered.

It is probable that school laboratories will present a high fire hazard because of the presence of piped gases, chemicals and other materials on benches. However, it is still important that pupils and staff in a laboratory can leave it quickly in the event of an incident that generates smoke/hot gases/toxic products. It is also important that the laboratory is in a compartment with a fire-resisting enclosure.

6.2 DESIGN AND TECHNOLOGY AREAS

These areas may be part of the school or be housed separately from the main general teaching areas. The main hazards are the build up of waste material like swarf or wood shavings in workshops, while 2D and 3D art materials will be found in art rooms. The way to reduce the risk is to be rigorous in house-keeping to make sure there is never a build up of waste materials and to ensure that completed pieces of work are removed from the work areas by the pupils.

The provision and storage of adhesives may need to be addressed. In art teaching areas, oil-based paints and thinners like linseed oil could also be a hazard.

6.3 DATA PROCESSING AREAS

Data processing areas will include dedicated IT resource and teaching areas, cyber cafes etc. It is quite common for ICT materials to be stored in one area and delivered to the pupils as needed. Many schools may also have a dedicated area for the server and specialist digital equipment like cameras. Valuable, specialist equipment may be susceptible to damage by heat or smoke as well as the means of extinguishing the fire, eg water. There is usually a low risk of fire but the rooms need to be enclosed in fire-resisting compartments to protect them from fire spread from elsewhere in the building.

![Figure 8 School server room in a primary school](image)

6.4 STORAGE AREAS

Storage areas may cater for a wide variety of materials depending on the size and age range of the pupils attending the school. It is accepted good practice to store waste materials in wheelie bins in locked stores well away from the main buildings particularly if the materials are combustible.

*Waste bins should never be stored adjacent to school buildings*

If housekeeping is poor and bin bags are left outside the school buildings then there is a high risk that an opportunist arsonist will set fire to them. The transfer of smoke and hot gases into the building then becomes a very real probability with the risk of a fire developing and the resultant property damage. Any flammable materials used in the laboratories or design and
technology areas must be kept in locked stores preferably away from the main part of the building(s). Where this is not practicable a fire-resisting enclosure should be provided for these stock rooms. High hazard stores (and boiler rooms) must not be accessed by a stairway common to other occupied parts of the school building(s).

Sports gear such as mats will need to be stored in locked cupboards as they can become involved in fires quite easily. School offices and medical rooms should be kept clear of flammable substances or they will become areas of high risk. The reduction in the risk is a matter of fire management during the everyday running of the school.

School cloakrooms have been identified by the Arson Prevention Bureau as the location of daytime arson fires. Hence the importance of their siting within the building, see Part 2.1. Note too, that open cloaks areas should never be sited close to, or off, single stairs.

6.5 KITCHENS

There are likely to be three types of kitchen or cooking area in a school

- For demonstration or teaching purposes
- For staff use
- For preparation of meals for the pupils, staff and possibly parts of the local community

Figure 9 Demonstration cookery area in primary school

Figure 10 Staff room in primary school, note cooking facilities at one end close to the fire exit, which is not very good practice in terms of fire safety.
School dining facilities may be sited in separate buildings, which has the advantage of isolating a ‘hot work’ area. The risk in any kitchen is high simply because it is where the food being cooked, or oils and fats used, can burn and cause a fire to spread.

The risk can be minimized by good management, using well-trained staff in the canteen or just for teaching purposes. If the risk assessment identifies an unacceptable likelihood of fire then automatic suppression should be considered (see Part 8.5). In any case hard-wired detection may be a useful investment, see Part 8.1. In the staff room where teachers strive to relax away from the pressures of their job they may be more at risk from fire involving any food or drink preparation as shown in Figure 10. The presence of detectors to alert occupants to the fire, fire exits to allow safe means of escape, as in the staff room, see Figure 9 and a clean and tidy environment will all serve to reduce the risk presented. Extinguishing agents such as fire blankets and portable fire extinguishers are dealt with in Part 8.4.

6.6 RESIDENTIAL ACCOMMODATION


While the guidelines summarised below may not appear to be directly related to fire issues, the spacing within and sizes of sleeping accommodation will have a direct impact on the possibility of fire spread while pupils and staff are asleep. Note too that some schools will let out their sleeping accommodation in the school holidays in which case those parts of the buildings will need to be certificated under the Fire Precautions Act 1971, although this will change as new legislation is enacted. In that case using the requirements for hotel accommodation will apply; this means 30min FR for common corridor walls with no ventilation or suppression and alarm systems in the main areas only. The bedroom walls will need to comply with ADE for acoustic reasons.

The Education (School Premises) Regulations 1999 with regard to Boarding has very strict guidelines on the spacing needed for pupils who board and present a sleeping risk. In a dormitory each pupil shall have 4.2m² with beds 0.9m apart. A cubicle for a single pupil shall have its own window and the floor area shall be not less than 5.0m². In addition there must be living accommodation of not less than 2.3m² for each pupil unless there is sufficient space in the study bedrooms or cubicles; or the boarding accommodation is adjacent to other school accommodation appropriate for such use. Medical rooms must be available if there are more than 40 boarders plus washing facilities, (there will need to be two if the pupils are more than eight years old). Spacing is more generous ie 7.4m² for each bed not less than 1.8m apart. For staff they must have separate accommodation which allows them to eat, sleep and wash. Storage facilities must be sufficient for belongings of the occupants and for bed linen. The hazards should be minimal, unless the pupils and staff smoke cigarettes, then the risk will rise sharply as there will be smokers’ materials around. Good discipline and smoke detectors giving early warning should reduce this risk.

For Means of Escape the recommendations in BS 5588: Part 1 and Part B of the Building Regulations and its guidance should be followed dependent on the type of layout of the accommodation provided. Within a dormitory housing a number of beds maximum direct travel distance from any point in the room to a door giving access to a protected lobby/corridor should be 9m where only a single door is provided and 18m where more than one exit is provided. Fire doors in residential buildings or parts of buildings used for residential purposes should meet the provisions for fire doors in Table C5.

It is necessary to provide some form of smoke control in common access corridors and/or lobbies in residential areas and within the escape stairs. This smoke control is there to aid means of escape and also to assist fire fighters. BS 5588: Part 1 describes the options
available to achieve the necessary standard of smoke control and BS 5588: Part 5 explains the level of smoke control necessary if a stair is also a fire fighting stair.

The Building Research Establishment (BRE) has published a report *Smoke Shafts protecting Fire fighting Shafts: their performance and design* (BRE Project Report No. 79204) which describes an alternative method for smoke venting of fire fighting shafts. Whilst not aimed specifically at residential buildings the approach recommended in the report has been adapted for use in some residential buildings. Designers wishing to use this approach will need to seek specialist advice.

BS 5588: Part 1 contains recommendations for the type and standard of fire alarm systems for residential buildings with more specific advice in BS 5839: Part 1: 2002, category L1 applies. BS 5588: Part 1 also contains recommendations for emergency escape lighting in flats and maisonettes, as does BS EN 1838/BS5266: Part 1.

When considering the installation of sprinkler systems it will be helpful to look at the recent BRE study of residential sprinklers the *Effectiveness of sprinklers in residential premises and the BASA Code of Practice on Sprinklers in Schools*. See Part 8.5

### 6.7 BOILER ROOMS

With the large numbers of pupils and staff using school buildings the need for efficient heating systems is very important. The new build option may be to have mains gas, solid fuel or oil-fired boilers for a wet system ie radiators. The relevant British Standards are BS 6768, BS 6644, BS 5410 Parts 1 and 2. For extensions and major refurbishments the chance to update the boilers may allow re-siting of the boilers at a distance from the main occupied parts of the school. Upgrading the fire separation and installing safety cut out devices and automatic detection is an alternative approach.

*Boilers should not be accessed from inside a building or extension of more than 250sqm and any access door should be a minimum of 5m away from a school entrance/exit.*

### 6.8 TEMPORARY ACCOMMODATION

It will be essential to consider providing independent or contained warning and escape provisions for temporary accommodation. Such temporary accommodation providing teaching areas etc because of shortage of space or because there has been loss of space due to a fire shall be treated as permanent accommodation with respect to fire safety.

![Figure 11 Aftermath of a fire in temporary accommodation](image)

*Courtesy of Staffordshire Fire and Rescue Service*

The costs of obtaining suitable temporary accommodation and the importance of fire safety provisions while it is on the school site will need to be addressed either as ongoing costs or as part of the rebuild. The siting of temporary classrooms etc will need to be discussed with
the fire authority so access for fire fighting is available. Much of the construction is likely to fairly easily become involved in fire and so should not be placed in direct contact with the remaining buildings on the site. Unfortunately there have been examples of fires started in materials stored under temporary classrooms that have spread into the adjoining permanent structures on site.

6.9 PUBLIC ENTERTAINMENT AND OTHER LICENCES

When a school invites members of the public to dancing, music, stage or film shows then a public entertainment, theatre or cinema license may be required. Shows put on by amateur dramatic societies using the school facilities will almost certainly require a public entertainment license. Any function at which alcohol is offered for sale will need a license, application for which should be made to the Clerk to the local Licensing Justices.

Other licenses are issued by local authorities under the terms of the Local Government Miscellaneous Provisions Act 1982 and will usually impose conditions, on amongst other things:

- the number of people to be present;
- the type of seating;
- the layout of the seating;
- the marking of emergency exits (including the provision of maintained signage); and
- the provision of emergency lighting.

All of these factors are elements of the Risk Assessment for fire safety.

It is probable that a fire officer will inspect the school before the license is issued and possible that checks will be made when performances are in progress to confirm that the conditions laid down in the license are being met. Under the proposed changes in the Regulatory Reform Order 2002 there should be a one-stop shop based with the fire authority.

However, there should be no need for a license for all events eg the primary school nativity play. Regardless of the need to apply for a license, the buildings should be operated within their safe limits. A Fire Risk Assessment should be undertaken by the school before any such event to ensure the safety of all concerned.
PART 7 ENGINEERING SERVICES

The range of possible engineering services that can be used in schools is:

- Gas services including calor gas
- Electrical services and wiring
- Lighting
- Heating and fuel storage
- Ventilation and air-conditioning systems
- Lifts
- Refuse storage and treatment.

Not all systems will be present in all schools. It is important to appreciate how these systems can impact on means of escape without the loss of good practice.

7.1 General
7.2 Lighting
7.3 Powered ventilation systems
7.4 Lifts
7.5 Gas supplies
7.6 Electrical services
7.7 Interaction of services

7.1 GENERAL

It has been common practice to run installation and piping for services through convenient parts of the building, even if these may be the protected stairway or lobby. This is not an example of good practice that is acceptable in new construction. When there is a refurbishment planned that should present an opportunity to re-site them.

In new build and extensions the escape routes must remain sterile to ensure no possibility of introducing a hazard that might prevent staff and pupils leaving the building safely. It is possible to reduce the hazard by enclosing the service in a fire-resisting cupboard, usually of half-hour construction. This is the way to deal with electrical risers and meters if they have to be present in protected stairways in existing premises; it is not acceptable in new build.

False ceilings are often the route for electrical and other links within a school and care should be taken to ensure that their installation is double-checked to avoid faults and fires that may remain undetected for a period.

Central heating systems rarely present a fire risk in school buildings; their installation is subject to Building Regulation control (Approved Documents G, J and L2 along with the revised BB87) and by the regulations relevant to the fuels used.

Where incinerators are present for the disposal of sanitary waste in the toilets they will present a fire hazard. Now that toilets have hand driers and other electrical equipment in them there is a risk present. Reducing the risk will be achieved by following the relevant guidance in BS 5588: Part 11 which addresses the problem of toilets opening onto protected escape routes. In which case fire doors should be fitted. In the pavilion style classrooms used in primary schools there are rarely any electrical fittings in the toilets, just a WC and hand basin.

BB70 Maintenance and renewal in educational buildings- maintenance of mechanical services offers practical guidance. It points out that carrying out maintenance on the basis of emergency need may cost a lot more than pre-planning. The economic costs of components are covered as well as their life expectancy.

Thus a longer term view of the building and its needs in life cycle terms should be taken on board by the designer, rather than just handing over a finished building or extension. The DfES has issued guidance on life cycle costing available on its AMP website www.teachernet.gov.uk/amps The perception of the building as possessing a life cycle from
green field to brown field is inherent in the thinking for fire safety engineering and the constant updating of the needs of the building at the various stages.

7.2 LIGHTING

All school buildings will have adequate artificial lighting and many areas within a school will benefit from natural light during the daytime hours. Regardless of this, it is appropriate to consider the nature and extent of emergency escape lighting which might be required to ensure the occupants can escape safely should the main lighting supply fail. DfES Building Bulletin BB90 Lighting design for schools together with BB87 Guidelines for environmental design in schools which addresses daylight issues raised in the new Approved Document L2 provide useful guidance. The DfES website [www.teachernet.gov.uk/schoolbuildings](http://www.teachernet.gov.uk/schoolbuildings) provides up to date information.

Although there is no requirement for emergency lighting in The Schools Premises Regulations 1999, which only includes reference to lighting levels ‘appropriate to its normal use’ as noted in Parts 2.5 and 3.2 above, it is good practice to install emergency lighting particularly with increased Community use of the school buildings. General guidance is given in BS EN 1838/BS 5266: Part 7: 1999 Lighting applications – emergency lighting. Further details are given in Part 8.2.

Ordinary lighting is likely to consist of luminaires at or just below the ceilings. If correctly installed these should present little or no hazard. Siting will be important if there is a sprinkler system present to avoid interference with the pattern of water distribution. BB90 Lighting design in schools covers these issues.

7.3 POWERED VENTILATION SYSTEMS

For new build low energy use and sustainability are now key issues for the designer, BB95 ‘Schools for the future’. This can be achieved by ensuring

- High levels of insulation
- Good use of daylight and natural ventilation
- High thermal mass in the walls and ceiling to avoid temperature fluctuations
- Good temperature control and lighting control systems.

In any school building whether new or existing, the ventilation system is likely to involve some ductwork/louvres. Where these cross a compartment wall which has a designed fire resistance, that fire resistance must not be compromised. BS 5588: Part 9, provides guidance on ventilation systems; BS 8313 on the installation of service ducts while mechanical ventilation should be installed in accordance with BS 5720.

Where the ventilation system has been designed to clear any smoke from a fire then a suitable detection system will be needed to actuate it, BS 5839: Part 1: 2002 provides guidance on the siting of the detectors. In some cases fire alarm systems must be linked to extract fans to shut doors in the event of fire.

7.4 LIFTS

As schools have become more inclusive the need for lifts to assist those pupils with limited mobility is increasingly widespread. During the course of a fire it is now recommended that such pupils are directed to a place of safety/refuge until they can be escorted out of the building, there shall be a place of refuge on each staircase. See ADM Access and facilities for disabled people 2004, which refers to BS 5588: Part 8: 1999. See also BS EN 81 Parts 70 and 72, 2003 Safety rules for the construction and installation of lifts. Most schools are two or three storeys high with a maximum of four storeys and will rarely need to comply with the requirement to provide a protected shaft to enclose a lift for fire fighters’ use as the building is over 18m high.
An alternative approach for schools is to treat all lifts as necessarily being evacuation lifts regardless of the height of the building – this will guarantee the safe evacuation of anyone with a mobility problem be it in a wheelchair or with a broken limb. It will also provide good access for fire fighters.

Occasionally there may be small lifts installed for the transport of items from a preparation room to a laboratory but these are rare and should not increase the risk of the spread of smoke and hot gases through the building.

Lift machine rooms should comply with the appropriate part of BS 5655.

7.5 GAS SUPPLIES

Gas supplies are most commonly to science laboratories and preparation rooms, kitchens and some design technology areas. Other uses are for space and water heating. The legislation covering this is Gas Safety (installation and use) Regulation 1998. Advice is given in the Institute of Gas Engineers 2004 publication UP11Gas installations for educational establishments.

7.6 ELECTRICAL SERVICES

All electrical services should be installed and maintained by suitably qualified engineers in accordance with BS 7671 (IEE Wiring Regulations) 2002 and The Electricity at Work Regulations 1989. Despite BB76 Maintenance of Electrical Services 1992 this is not a job for the school handyman. Uninterrupted power supplies fitted to BS EN 50091 will ensure that circuits will continue to operate and the circuits will maintain their integrity in the event of a fire in the building.

With the increase in ICT, CCTV and other equipment it is sensible to ensure that mineral insulated cabling conforms to BS 6207: Part 3: 2001 (or to BS 6387 :1994 if classed CWZ cable) or BS 5839: Part 1 for most cabling systems. The alternative is to separate all cables from exposure to a fire by putting them behind a fire-resisting construction such as a wall, partition or floor. Note that conduit, ducting and trunking are unlikely to provide protection against fire. All wiring will need to be protected from mechanical damage.

Although the concept of a secondary power system is appealing to prevent interruption to essential supplies to experiments for example, this will often prove too costly to do more than consider it as an option. In the rare instances where a secondary power supply is needed the design engineer will need to choose a system that will stay working for at least three hours. This is only likely if there is to be say a powered smoke extract system or a dedicated link to the local Fire and Rescue Service communications/receiving system. In any event the distribution should be arranged so that the secondary system remains live when the remainder of the supplies in the building are isolated because of the fire.

Secondary systems are necessary if there are any of the following in the school

- Sprinkler pumps
- Wet riser pumps for the hose reels
- Fire-fighting lifts
- Fire fighter communications
- Pressurisation fans (air supply and pressure relief)
- Depressurisation fans (air supply and pressure relief)
- Smoke control system.

Pressurisation may, for example, be incorporated into a restricted site in a metropolitan area.

7.7 INTERACTION OF SYSTEMS

For any of the systems mentioned above it is imperative that each one should be designed and installed to work at its optimum criteria. Further it is essential that the various systems do not impede the workings of any other system.
PART 8 FIRE PROTECTION FACILITIES

For designers to take the holistic approach to the safety of the occupants and the fabric of the building in the event of a fire, certain facilities will need to be incorporated into the building(s) although they may not be regulatory requirements. In order to provide early warning of a fire, an automatic fire detection system will need to be installed, along with emergency lighting so that exit routes are clearly indicated. Smoke control both for escape and fire fighting ensures that the duty of care towards both the occupants and the fire fighters has been provided and will anticipate extended or community use of the school.

In addition the means for first aid fire fighting and possibly a fire suppression system such as sprinklers should be considered. Under the Workplace Regulations employees are not expected to try and fight a fire unless they have been trained and are confident that they can do so, see the Home Office/HSE document on Fire Safety - An employer’s guide. Any delay will be offset by the provision of adequate water supplies for the professional fire fighters to use, plus suitable access and facilities for them.

Good security with controlled access to the school buildings can be a major factor in reducing the incidence of arson fires. This will need to be carefully planned in conjunction with other agencies such as the police and fire service.

8.1 Automatic fire detection
8.2 Emergency lighting
8.3 Smoke control
8.4 First aid fire-fighting equipment
8.5 Automatic fire suppression systems
8.6 Water supplies
8.7 Access and facilities for the Fire and Rescue Service
8.8 Security and the prevention of arson.

8.1 AUTOMATIC FIRE DETECTION

Although the staff and pupils provide an excellent source of mobile smoke detectors as they may be expected to see a fire starting and/or smell the smoke this is not a reliable detection system. People are not present in all parts of the building nor are they there day and night, every day (24/7). Early detection and alarm of the fire will allow occupants to escape quickly and safely. It will enable professional help to be summoned without delay which should reduce the damage to the fabric and contents of the building(s).

Photo courtesy of Chris Houston

Figure 12 ‘reduce the damage..’
One of the first considerations needs to be to decide what type of detection system to install.

- Is it for life safety and/or property protection?
- Should it be automatic or manual?
- Will it need to be linked to the central monitoring station?
- Will it need to be linked to hold open devices on doors?
- What sort of sounders?
- Should there be a voice alarm system tailored to the needs of the school?
- Are any of the people present likely to be hearing impaired? What means are there to alert them to a fire?
- Are any of the people present likely to be visually impaired? What means are there to alert them to a fire?
- Are any of the people present likely to be mobility impaired? What means are there to alert them to a fire?

The answers to these queries will determine the level and complexity of installation. In addition detectors need to be robust to resist the attempts of vandals to damage them; careful siting of break glass call points will also be needed.

If a suppression system is installed it will have the added bonus that there will be heat detectors throughout the school which may lead to overall savings.

For core hours use and in temporary accommodation Category M systems would probably be sufficient for life safety purposes. However, where the building is complex or used out of hours and has or will have inclusive use then an appropriate L system will be the most effective for life safety. The decision will depend on the projected use of the buildings both at the time of the design and in the foreseeable future.

For guidance on system design, installation and servicing BS 5839: Part 1: 2002 provides all the information a designer will need. Category P automatic systems are for property protection and Category L for life protection. Category M is the manual system providing break glass call points and sounders.

Category L is split into L1, L2, L3, L4, and L5. L1 is the more costly system as it provides detection throughout the building including all the voids that the installer can reach. This may be worth costing where there is a lot of expensive ICT and other equipment as in secondary and/or boarding schools. L2 systems are cheaper as the detectors are confined to the escape routes and any high risk areas – perhaps sufficient for the pavilion type primary school. L3 is purely for the escape routes, suitable for the one roomed school perhaps, while L4 is for those parts of the escape routes that comprise circulation areas and circulation spaces such as corridors and stairways. For any other specific areas not already covered L5 systems can be used. The P system mirrors that of L for P1 and P2. The specification will indicate the level of life and property protection eg L3/P2. L2 is suggested as the minimum level of installation, but the choice will need to be balanced by the hazards presented in the building, its complexity and the funding available. If arson is a high risk in the school locality consideration must be given to the category P systems as well.

Once the alarm has sounded there must be a planned response so that evacuation is started immediately, the Fire and Rescue Service is called and first aid fire fighting can start if appropriate. Linking the system to a Central Monitoring Station may overcome the out of hours problem when there is no-one present and the buildings might be vulnerable to arson attack. However, this will be an additional cost and because of the need to avoid false alarms the local Fire and Rescue Service may only attend if the fire is confirmed by a person.

**8.2 EMERGENCY LIGHTING**

Emergency escape lighting is required (BS EN1838/BS 5266) to fulfil the following functions:

1. Clearly indicate and illuminate escape routes and exit signs, including escape routes which are external to the building.
2. Ensure that changes of level and direction are indicated in accordance with ADM
3. Ensure that fire alarm call points and fire-fighting equipment can be easily located.

Emergency lights can be powered by battery or a back up generator; battery systems are more common and cost effective in most school buildings but must be checked regularly. It is usual to find a small red LED indicating that the light is ‘live’ and will come on in the event of an emergency. Further guidance on emergency lighting is given in BB90 Lighting design for schools.

In Part 3.2 above the provision of emergency lighting was discussed in the context of the minimum requirement for areas accessible to the general public during the evenings. These include halls and drama spaces used for performances, specialist and other spaces used for community education. Emergency lighting has not usually been provided on escape routes, except from public areas. This was because pupils are generally familiar with the buildings however, during the winter period when darkness is common for part of the day as well as the very real possibility of power failures, emergency lighting should be provided throughout the school as standard. Indeed the increasing Community use of schools, when members of the public will have access to such areas as Design and Technology areas including Art Rooms, Food Technology, Language Rooms, Sports Halls, drama spaces and School Halls, means it is essential in these areas. It is therefore better to consider the life cycle of the school and the broadening use of facilities and fit emergency lighting based on the assumption that all the buildings will be used for large parts of any twenty-four hour period. Pyrotechnic events, such as indoor fireworks, should not be permitted at any time within the building.

In most cases it will be sufficient to have a system of ‘non-maintained’ emergency lighting i.e. where the luminaires are only illuminated if the normal lighting fails. If areas are to be used for activities which might require some form of licensing e.g. public entertainments licensing, then a system of ‘maintained lighting’ would be required in these areas. With a ‘maintained’ system the emergency luminaires are illuminated at all times.

8.3 SMOKE CONTROL

There are two main reasons for the control of the spread of smoke - to protect means of escape and to assist fire fighting.

Protecting escape routes from the effects of smoke or toxic fumes from a fire is normally achieved by the passive means of physical protection ie smoke control doors, lobbies and impermeable separating elements (see Part 4). (It must be noted that buildings are leaky and some smoke will always pass through door cracks etc.) This physical protection, coupled with the required number of exit routes achieving adequate travel times, is usually sufficient to satisfy the requirements for means of escape. These measures, when properly implemented and maintained will slow down smoke penetration of escape routes allowing more time to leave safely as well as aiding fire fighting, search and rescue.

Thus, smoke containment is generally adequate for the majority of school buildings and other forms of smoke control, either natural or mechanical systems, are not usually necessary to aid means of escape. In some circumstances the design may need to take account of staircase protection eg via a pressure differential system, in which case the relevant class system from BS 5588 Part 4 should be referred to.

However, where the design of a school building incorporates unusual features, such as large uncompartmented spaces eg a sports hall or an atrium, some form of active smoke control might be appropriate; because of the sprinkler requirement an upper limit of 800sq m could be taken before the compartment requires active smoke control. Sports halls in schools are usually in the order of 600 sq m and therefore will normally be a compartment of its own. Such a system would need to prevent smoke spread through the building and keep the escape routes free from smoke. In this way the smoke control system would compensate for the lack of compartmentation, or any reduction in the physical protection to escape routes.
Note: the new Building Bulletin 93 on acoustics will probably lead to an increase in compartmentation, particularly in secondary schools. Information is also available on the website [www.teachernet.gov.uk/schoolbuildings](http://www.teachernet.gov.uk/schoolbuildings).

Other than for smoke ventilation of basements, present in some existing buildings, and some specific building types, smoke venting to assist fire fighting is not a statutory requirement. However it must be acknowledged that the build up of smoke and heat, as a result of a fire, can seriously hinder fire fighting and rescue operations by the fire service. Therefore, where possible, facilities should be designed into a school building to enable heat and smoke to be vented to the outside air. These facilities are intended to assist the Fire and Rescue Service in carrying out fire-fighting operations and are not intended to assist means of escape, other than in special circumstances such as the large un compartmented space mentioned above.

*Effective means of escape continues to rely on the provision of a suitable number of exits and protected escape routes.*

In most school buildings adequate smoke venting can be achieved by providing openable windows or roof lights as part of the design. With regard to the amount of ventilation required in a simple system of openable windows or roof lights (or smoke outlets from a basement), it is generally accepted that an aggregate area of 2½% of an individual floor area would be acceptable. The windows should, as far as possible, be spread evenly around the storey perimeter to induce cross-ventilation and be provided with simple lever handles or locks that can be operated by the Fire and Rescue Service. From ordinary non-fire considerations, some windows will be provided with (lockable) restrictors or motorised actuators to meet the requirements in Regulation 13 of the Workplace (Health, Safety and Welfare) Regulations 1992 to prevent people falling out of the building. Properly designed fire safety provisions should not be so expensive and specialised that they compromise other design considerations for the comfortable and safe everyday use of the building.

Although this design guidance does not encourage the inclusion of basements in a design for new build there will still be some schools on restricted sites that may need to include them or they may be present in existing buildings. Where basements are present venting of heat and smoke from them can be by the provision of smoke outlets where the floor area is more than 200m² with a floor not more than 3m below the adjacent ground level. Smoke outlets are not needed where there are external doors or windows. Smoke outlets should be sited at high level and distributed around the perimeter area to discharge to open air outside the building. They should be covered with a non-combustible grille or louvre if not readily accessible and by a panel that can be broken if readily accessible. Outlets should not compromise any escape routes out of the building. Mechanical extraction is an acceptable alternative provided the basement is fitted with sprinklers in accordance with BS EN 12845/BS 5306: Part 2. The system should give ten air changes per hour capable of handling gas temperatures of 300°C for at least one hour.
Another area to consider is the stairs which must be kept clear of smoke to assist safe egress. Effective means of smoke removal must be incorporated – ventilation from the head of the stairway can be by natural or mechanical means through suitable smoke outlets.

Where the design necessitates an engineered approach to smoke ventilation in large spaces, advice on the design of such systems can be found in BRE Report BR 368, BS7346: Part 4:2003 or CIBSE Guide E. For specific building types e.g. a building containing an atrium, advice is contained in BS 5588 Part 7.

If it is proposed to incorporate a system of smoke venting in a school, other than a simple system of openable windows or roof lights, then it would be appropriate to seek the advice of a qualified fire engineer as well as early consultation with the fire authority and the building control body. It may be that such a system would impact on means of escape as well as providing assistance to fire fighters.

8.4 FIRST AID FIRE-FIGHTING EQUIPMENT

Regardless of whether or not sprinklers are provided in a school there are still benefits associated with having portable first aid fire-fighting equipment readily available. Properly used by a trained person on a fire is in its early stages it can be effective in preventing the fire growing and spreading.

First aid fire fighting should be considered in the context of the potential users of the building; extinguishers and fire blankets will need to be provided. Access for the Fire and Rescue Service may mean providing a source of water for fire fighting.

The most common types of equipment are hand held fire extinguishers. While hosereels have a continuous supply of water to fight the fire their use is not recommended as they are too often a stimulus to vandalism as well as perhaps encouraging people to stay close to the fire for too long. Portable fire extinguishers on the other hand have a finite supply and the general advice given is to only start fire fighting if the fire is roughly the size of a football. First-aid fire fighting should only be undertaken by persons trained in the use of hand held extinguishers confident that they can use them effectively.
The choice of fire extinguisher depends on the nature of the risk likely to be encountered. Fires can generally be classified into five groups, see BS EN 3: 1996

- Class A: Fires involving wood, paper, rags or other solid materials
- Class B: Fires involving liquids
- Class C: Fires involving gases
- Class D: Fires involving metals
- Class F: Fires involving cooking oils and fats

Note: the Local Education Authority/ Governing body/ Responsible Person will doubtless have a policy on the provision of fire-fighting equipment. This policy will inform the choices of the designer of a new build/major refurbishment who will need to balance the costs of installation and maintenance for the life of the building against that of a sprinkler system. The latter may then become a more attractive option.

Whatever type of fire extinguishers are used, their siting in the building should, as far as is practicable, be standardised, especially if the building is on several levels. A shelf or bracket should be provided for every extinguisher so that the handle or carrying device of the extinguisher is about 1.1m above floor level. All extinguishers should be tested and maintained in accordance with BS 5306: Part 3: 2000.

In laboratories it would also be beneficial to have one or more buckets of cat litter available together with the appropriate fire extinguisher. Cat litter is useful for containing spillages of most flammable or other heavy liquids provided it is not made from waste paper. Sand is useful for phosphorus fires and the Schools Science Service recommends that for the small number of schools still holding stocks of phosphorus 'it would be better to keep a sample of clean, dry sand in a plastic bag, labelled for use on phosphorus fires, adjacent to the bottle of phosphorus and issue them both together.'

For general use in school kitchens one or more Fire Blankets, according to the size of kitchen, would be appropriate. The Fire Blanket should comply with BS 6575 Specification for Fire Blankets. It should be sited in easy reach of the cooker/fat fryer.

### Type of Fire Extinguishers

**Their uses and their colour coding according to BS EN 3 : 1996**

The contents of an extinguisher is indicated by a colour zone on the body of the extinguisher:

- **Water**: For wood, paper, textile and solid materials
  - DO NOT USE on liquid, electrical or metal fires
- **Powder**: For liquid and electrical fires
  - DO NOT USE on metal fires
- **Foam**: For use on liquid fires
  - DO NOT USE on electrical or metal fires
- **Carbon Dioxide**: For liquid and electrical fires
  - DO NOT USE on metal fires

**Note** Halon extinguishers are not shown as they are no longer permitted in the UK

*Figure 14 Types of fire extinguisher*
Table 1 Recommended type and location of fire-fighting apparatus

<table>
<thead>
<tr>
<th>Type</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>Design and Technology spaces</td>
</tr>
<tr>
<td>(in general one 13A² rated extinguisher per 200 square metres adjusted up or down depending in the types of risk, with a minimum of one per floor)</td>
<td>Stages of every assembly hall</td>
</tr>
<tr>
<td></td>
<td>Residential areas of boarding schools</td>
</tr>
<tr>
<td></td>
<td>On escape routes, so that the walking distance to the nearest extinguisher does not exceed 30m</td>
</tr>
<tr>
<td>Foam or dry powder</td>
<td>Laboratories¹²</td>
</tr>
<tr>
<td></td>
<td>Food Technology ²³</td>
</tr>
<tr>
<td></td>
<td>Kitchens</td>
</tr>
<tr>
<td>Foam</td>
<td>Boiler rooms where oil fuel is used</td>
</tr>
<tr>
<td>Carbon dioxide or dry powder³</td>
<td>Electrical switch rooms and places where live electrical equipment is known or thought to be present, eg. stage lighting control areas and ICT classrooms</td>
</tr>
<tr>
<td>Dry powder</td>
<td>Vehicle protection</td>
</tr>
<tr>
<td>Fire blankets</td>
<td>Adjacent to fire extinguisher in kitchens, laboratories, design technology practical spaces and assembly halls</td>
</tr>
<tr>
<td>Fire buckets containing cat litter as extinguishing agent</td>
<td>Two in each laboratory adjacent to extinguishers.</td>
</tr>
</tbody>
</table>

1. *In some laboratories where very volatile liquids are used or fragile equipment is installed, dry powder or carbon dioxide may be preferable to foam.*
2. *In laboratories and Food Technology, the capacity of extinguishers should be: for water about 9 litres capacity (13A rated), dry powder about 1.5 kg and carbon dioxide not less than 2.5 kg.*
3. *Where there is no fixed frying equipment, dry powder may be preferable to foam.*
4. *Dry powder and carbon dioxide do not conduct electricity.*

8.5 AUTOMATIC FIRE SUPPRESSION SYSTEMS

Taking the holistic approach and recognising the effects of arson, it is important to protect the property as well as to protect the lives of the people going into the buildings. However, only life safety is a statutory requirement under the Education (School Premises) Regulations 1999. A Risk Assessment and a comparison between additional security, detection and suppression measures will still be needed. An option appraisal could also be carried out in a local authority area. School buildings are a special case and if destroyed in a fire the loss to the Community can be far reaching and so the property protection aspect is as important as life but only in this particular type of building.

Where arson is a regular occurrence in say inner city secondary schools based on a risk assessment they should install an automatic fire suppression system ie a sprinkler system as a good investment for both life and property protection, BS EN 12845. Sprinklers are known to be highly effective in controlling a fire while it is still small and certainly buying time before the arrival of the Fire and Rescue Service. However, there is obviously a cost implication up to 5% of a building contract whether for new build or to upgrade existing buildings. Some school owners may decide that this is a worthwhile expenditure based on a risk assessment in their buildings in their area, see below.

Where the risk analysis highlights the fact that an ignition is probable, possibly as a result of location, the existence of certain processes or other socio-economic factors, then the fitting of automatic fire suppression systems will need serious consideration. Fire suppression systems can take the global form in the case of sprinklers or in a localised form such as
gaseous or water mist systems which will target identified hazards. Sprinkler heads can be concealed from the interested gaze of the pupils which should minimise efforts to set them off. There is the added bonus that a sprinkler system will result in a heat detection system.

Case study
A public school which is in a listed building of Georgian design on three floors was risk assessed and it was found that there was no good alternative escape route. The safe evacuation of boarders was in question. One solution was to add an external staircase to the building; this looked dreadful even on the plans. The solution was to fit sprinklers to protect the existing escape route. The cost in this case was less than the external metal staircase.

The question of whether a fire suppression system such as sprinklers should be fitted will depend on several factors all of which should be identified in the risk assessment.

- probability of the event
- consequences of the event
- location of the buildings,
- how accessible they are,
- vulnerability to intruders through the perimeter of the site,
- is there public access to the site,
- vulnerability of the construction to fire involvement
- how good the security system is,
- waste disposal and storage well away from the buildings to prevent an external hazard coming into contact with the fabric of the building,
- previous history of vandalism and arson,
- how long it takes the Fire and Rescue Service to reach the buildings and fight the fire,
- how good the water supply is.

In an existing school it might be more cost effective if the passive fire safety measures along with the security are upgraded. The choice will depend on the Risk Assessment. If a sprinkler system is to be considered then one practical consideration will be its vulnerability to abuse. One solution would be to fit a concealed system to try and prevent pupils seeing if they can set the system off. An alternative could be a dry system relying on a ‘double knock’ (pre-action) detection system before activating. If there is a good water supply or one can be provided then there is a good chance that the fire will be controlled by the sprinkler system. There is no doubt that a working sprinkler system is extremely effective against fires within the building and should control the heat output from any fire if not actually extinguish it, thus buying time during which the Fire and Rescue Service can get to the school. But there still needs to be a mechanism for calling the brigade. A fully automated zoned fire detection system with a direct link to a central monitoring station is the best way to get rapid attendance by the brigade, especially out of school hours. However, this may still need to be confirmed by a 999 call in the light of concerns about false alarms.

The Arson Prevention Bureau cites 11pm at night as the most popular time for arsonists to act. During the day there is an effective detector present in the noses of all the occupants. Many arsonists are opportunistic and will use any materials that are lying around, hence the need for regular waste disposal with any stored material locked well away from the school buildings themselves. Where space is at a premium, external drenchers may be a useful addition to prevent external fires penetrating the building.

Where a school has a kitchen and caters for its pupils on a regular basis the risk of a kitchen fire will be high as this is a hot work area. Consideration should be given to providing a proprietary extinguishing system in cooker hoods.

8.6 WATER SUPPLIES

Water supplies for fire fighting are normally provided from fire hydrants. These can be hydrants belonging to the local water authority or private hydrants installed by the developer or owner of a specific site. Even where there are a number of local authority hydrants around
a site or school building it may be necessary to install one or more private hydrants. BS 750 provides guidance, on the site if the building is set back or is some distance from the public highway. The hydrants should be no more than 70m away from an entry point into the building and not more than 150m apart.

Hydrants must be capable of supplying sufficient water at suitable pressures ie a minimum of 1500 litres/min sufficient for a fire-fighting jet. Generally hydrants need to be located in positions which are both near to building entry points and to fire appliance parking positions. This criterion applies whether fire appliance access is at ground level, below ground or from a podium or upper deck level. Note that if a building has a suppression system there may not be so great a need for hydrants. Water supplies are subject to variation throughout England and Wales. It would be prudent to consult the Water Undertaker in the local area about available water supplies before a sprinkler system is designed and installed in the building.

If sufficient mains water is not available then a bulk or static supply should be provided as part of the designed sprinkler system. This capacity would need to be discussed and agreed with the fire authority. A minimum capacity would be 67,500 litres which is sufficient to supply three fire-fighting jets for 45 minutes.

An unlimited water source, which is guaranteed, might also be acceptable to the fire authority. Whatever form this might take there would need to be adequate access and hard standing for fire appliances. The nature of the water supply, access and hard standing provisions will need to be discussed and agreed with the fire authority and any other enforcing authority.

**8.7 ACCESS AND FACILITIES FOR THE FIRE SERVICE**

Should a fire occur in a school it is obvious the sooner the Fire and Rescue Service can gain access to the affected building and commence fire-fighting operations, the better chance they have of controlling the fire and reducing property damage. To assist them, the designer must ensure that fire service appliances can gain ready access to the site and to part or all of the perimeter of the buildings and fire fighters can achieve ready access into and all round the building.

Depending on the height or depth of the building(s), protected fire-fighting shafts may be required in accordance with BS 5588 Part 5 although for many school buildings this will not be the case as they will be single-storey buildings. Fire-fighting shafts are provided to give fire fighters a safe protected route from the outside of a building and more importantly a safe exit route if required to all the upper or below ground floors. If the risk assessment shows that fire-fighting shafts are of benefit or necessary they will always contain a fire main (dry rising main) which serves all floors above and dry falling mains for floors below ground. The dry rising main allows water to be quickly pumped to any floor without fire fighters having to drag heavy hose up stairs or haul it aloft from outside the building.

It is important to note how much space will need to be provided in terms of width of roadways etc, see Table 2, to allow fire appliances access and turning circles in order to get away from the site, Figure 15.
Figure 15 Turning facilities

Table 2  Typical fire service vehicle access route specification

<table>
<thead>
<tr>
<th>Appliance type</th>
<th>Minimum width of road between kerbs (m)</th>
<th>Minimum width of gateways (m)</th>
<th>Minimum turning circle between kerbs (m)</th>
<th>Minimum turning circle between walls (m)</th>
<th>Minimum clearance height (m)</th>
<th>Minimum carrying capacity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump</td>
<td>3.7</td>
<td>3.1</td>
<td>16.8</td>
<td>19.2</td>
<td>3.7</td>
<td>12.5</td>
</tr>
<tr>
<td>High Reach</td>
<td>3.7</td>
<td>3.1</td>
<td>26.0</td>
<td>29.0</td>
<td>4.0</td>
<td>17.0</td>
</tr>
</tbody>
</table>

1. Fire appliances are not standardised. Some fire services have appliances of greater weight or different size. In consultation with the Fire Authority, the Building Control Body may adopt other dimensions in such circumstances.

2. Because the weight of high reach appliances is distributed over a number of axles, and they are only used occasionally they should not cause any damage to a carriageway or route designed to 12.5 tonnes rather than the full 17 tonnes capacity.

If the building is not fitted with fire mains, vehicle access to areas of the building should be provided in accordance with Table 3.

Table 3  Fire service vehicle access to school buildings (excluding blocks of flats) not fitted with fire mains

<table>
<thead>
<tr>
<th>Total floor area of building m²</th>
<th>Height of floor of top storey above ground (2)</th>
<th>Provide vehicle access to (2) to:</th>
<th>Type of appliance</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 2000</td>
<td>up to 11</td>
<td>see Note 3</td>
<td>pump</td>
</tr>
<tr>
<td>over 11</td>
<td>15% of perimeter</td>
<td>high reach</td>
<td></td>
</tr>
<tr>
<td>2000-8000</td>
<td>up to 11</td>
<td>15% of perimeter</td>
<td>pump</td>
</tr>
<tr>
<td>over 11</td>
<td>50% of perimeter</td>
<td>high reach</td>
<td></td>
</tr>
<tr>
<td>8000-16,000</td>
<td>up to 11</td>
<td>50% of perimeter</td>
<td>pump</td>
</tr>
<tr>
<td>over 11</td>
<td>50% of perimeter</td>
<td>high reach</td>
<td></td>
</tr>
<tr>
<td>16,000-24,000</td>
<td>up to 11</td>
<td>75% of perimeter</td>
<td>pump</td>
</tr>
<tr>
<td>over 11</td>
<td>75% of perimeter</td>
<td>high reach</td>
<td></td>
</tr>
<tr>
<td>over 24,000</td>
<td>up to 11</td>
<td>100% of perimeter</td>
<td>pump</td>
</tr>
<tr>
<td>over 11</td>
<td>100% of perimeter</td>
<td>high reach</td>
<td></td>
</tr>
</tbody>
</table>

1. The total floor area is the aggregate of all floors in the building (excluding basements).
2. An access door not less than 750mm wide is required to each elevation to which vehicle access is provided, which gives access to the interior of the building.
3. Access to be provided for a pump appliance to either (a) 15% of the perimeter, or (b) within 45m of every point on the projected plan area of the building whichever is the less onerous.
8.8 SECURITY AND THE PREVENTION OF ARSON

Arson is a crime and should be preventable. Where local authority areas have addressed this problem using a multi-agency approach the results can be extremely good. Regular discussions held between the local education authority, the Fire and Rescue Service and the police will identify areas where the fires are occurring. This will ensure that community risk management principles will be the basis of tackling the problem and developing best practice solutions resulting in the eradication of arson. The information so gathered can then be incorporated into the LEA briefing document.

However, arson continues to be the major cause of fires in school buildings with fire losses reaching levels which cannot be tolerated given the finite levels of school funding available. It is crucial that a risk assessment is made and if the school is shown to be at risk from arson measures to improve security and reduce the threat of arson are included in any design for a new school or major extension/refurbishment of an existing school.

It is important to assess any proposed or existing school building in the light of the known or assessed risk of the location. This will require advice from the police and fire authorities at an early stage. Recommendations on the construction of the external envelope of school buildings to reduce their vulnerability to arson attack are given in Section 4. A check list of factors to be considered includes the following:

- Boundary security to suit location and level of risk
- Controlled site access
- Reduction of concealed entrances or areas which offer cover to intruders
- Limited entrances to site and buildings
- External lighting, particularly to hidden or vulnerable areas
- Combustible materials or rubbish in secure locked stores away from buildings or boundaries
- Fire and security alarms
- Security locks and robust door and window ironmongery
- Provision of secure zones, rooms, stores, cabinets or safes
- Landscaping to enhance the building without providing cover to intruders
- Prevention of access to roofs (eg: from surrounding buildings or walls, or from within the site)
- Maximise the use of video surveillance.

A great deal of work to combat arson in schools has been carried out by the Arson Prevention Bureau who have published a comprehensive guide “How to combat arson in schools (July 1998)”. The guide identifies the nature of arsonists and gives guidance on assessing a school’s vulnerability to arson attack. It also contains detailed guidance on developing an action plan against arson.

To reduce arson the main objectives should be to:

- Deter unauthorised entry onto the site.
- Prevent unauthorised entry into a building.
- Reduce the opportunity for an offender to start a fire.
- Reduce the scope for potential fire damage.
- Reduce subsequent losses and disruption resulting from a fire.

The guide contains specific advice on how the five main objectives might be met and this guidance can be applied to the design of new schools or the extension/refurbishment of existing schools. There is further advice in Guide 4 Improving Security in Schools and Guide 6 Fire Safety in the DfEE Managing School Facilities’ series. The police and fire authority should be consulted on any measures considered necessary to reduce the threat of arson on a continuing basis during the life of the school.
PART 9 FIRE SAFETY MANAGEMENT

Because the occupants of school buildings range from three years old upwards they must enjoy the highest standards of management to ensure that risks are anticipated and covered by the best possible systems for both life safety and property protection. There are legislative requirements placed on those responsible for schools to maintain proper levels of health and safety including those related to fire. Requirements are included in such legislation as Regulation 17 of the Education (School Premises) Regulations 1999; the Health & Safety at Work etc. Act 1974; and the Fire Precautions (Workplace) Regulations 1997 (as amended 1999).

Management of fire safety must be integrated with all other management systems in the school. If this management is lacking then there is a danger that all the other areas such as security measures and alarm systems will be ineffective. To ensure there is no doubt as to where the responsibility for fire safety rests, and to enable consistency of approach, it is important that each establishment appoints a designated Fire Safety Manager. This should be a senior appointment preferably at Head or Deputy-Head level. It may be possible to appoint a professional to take on this role but that will depend on the size of the premises, costs etc.

The appointed person should have the necessary authority and powers of sanction to ensure that standards of fire safety are maintained.

The main duties of the Fire Safety Manager are to:

- carry out hazard and risk assessments, particularly of any proposed changes
- be responsible for fire safety training;
- produce an Emergency Fire Plan;
- conduct practice fire drills;
- check the adequacy of fire-fighting equipment and ensure its regular maintenance;
- ensure fire escape routes and fire exit doors/passageways are kept unobstructed and doors operate correctly;
- conduct fire safety inspections at least once each term or when there are changes to the fire risk assessment;
- make more frequent informal checks to confirm that the fire safety rules are being followed;
- ensure that fire detection and protection systems are maintained and tested and proper records kept;
- ensure any close down procedures are followed;
- consult with and implement recommendations of the local Fire and Rescue Service if a regulatory requirement
- include fire safety in the regular health and safety reports to the governing body

Given the increased use of school premises for other activities outside of normal school hours, it is important that the Fire Safety Manager includes this aspect when considering the fire safety issues. There is a cost to implementing these actions and the school will be expected to implement those that are reasonable and within their financial limits. Anything beyond will probably need to be discussed with the LEA or building owner to obtain additional funding.

There is considerable guidance on how to meet the above duties contained in Fire Safety Guide No.6 (DfEE) in the Managing School Facilities series and in Fire Safety - An employers guide (Home Office/HSE).

9.1 ROLE OF THE HEAD TEACHER AS RESPONSIBLE PERSON

As the owner of the building(s) the local authority will usually delegate the running of the school to the Governing Body with the day to day management of the school in the hands of the Head Teacher. This means that the Head Teacher will be regarded as the Responsible Person with respect to carrying out risk assessments for the Workplace Regulations (and
under the Regulatory Reform Order 2002). In turn, this means that he/she will need appropriate training and budget to carry out these duties. Some local authorities may keep the responsibility for their schools but will need to liaise with the Head Teacher and staff to ensure fire safety provisions are appropriate to the needs of the pupils and staff.

The responsible person will have to review the assessment regularly to keep it up to date and if it is suspected that it is no longer valid or there has been a significant change in the premises, such as extensions or conversions or the organisation of the work undergoes significant changes. If changes to the assessment are required the responsible person will have to make them. This is the basis of dynamic risk assessment, ie it is an ongoing process and the responsible person cannot forget about the process having done it once. The significant findings must then be recorded along with the measures taken to address the risks identified.

9.2 FIRE STRATEGY DOCUMENT FOR SCHOOLS

The Head Teacher is always going to be a very busy person with enormous demands on their time. For this reason a simple tick list of topics that need to be covered for every assessment is given below.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Yes/No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have there been any changes in the use of the school buildings?</td>
<td></td>
</tr>
<tr>
<td>Has the role of the staff changed in any way?</td>
<td></td>
</tr>
<tr>
<td>Have the escape routes been altered in anyway?</td>
<td></td>
</tr>
<tr>
<td>Has the school been redecorated? Were there any changes in the type of</td>
<td></td>
</tr>
<tr>
<td>materials used?</td>
<td></td>
</tr>
<tr>
<td>What was used? Was the flooring changed?</td>
<td></td>
</tr>
<tr>
<td>Have the furnishings changed?</td>
<td></td>
</tr>
<tr>
<td>Are you using any of your specialist areas differently? For example -</td>
<td></td>
</tr>
<tr>
<td>are the laboratory preparation rooms being used more for storage?</td>
<td></td>
</tr>
<tr>
<td>When were the last maintenance checks of the engineering services done?</td>
<td></td>
</tr>
<tr>
<td>When were the last checks on the fire protection facilities done?</td>
<td></td>
</tr>
<tr>
<td>When did the staff last have fire safety training?</td>
<td></td>
</tr>
</tbody>
</table>

Note that a change of use can just mean a one off event such as an Open Day, School Play, Concert or Sports Day. Once any assessment has been done the Head Teacher will need to make a record of the findings and outline any actions that need to be carried out.

For schools that have opted out or are independent there will be greater freedom for the Governing Body to appoint outside specialist consultants to do the risk assessments at regular intervals on their behalf. Consultants will be responsible for the outcomes from their assessments.
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APPENDIX A PLANNING THE ESCAPE ROUTES

Regulatory guidance in support of Building Regulations defines the basic principles for the design of means of escape as:

a. ‘that there should be alternative means of escape from most situations’
b. ‘where direct escape to a place of safety is not possible, it should be possible to reach a place of relative safety, such as a protected stairway, which is on a route to an exit, within a reasonable travel distance. In such cases the means of escape will consist of two parts, the first being unprotected in accommodation and circulation areas, and the second in protected stairways and in some circumstances protected corridors.’

The ultimate place of safety is the open air away from the effects of the fire. Regulatory guidance goes on to recognise that in ‘modern buildings which are large and complex, reasonable safety must be reached within the building, provided suitable planning and protection measures are incorporated.’ This allows for places of refuge within the building before those escaping the fire can reach the final exit. Further ‘any person confronted by a fire within a building can turn away from it and make a safe escape’ i.e. people should be able to leave the building with the fire behind them. Dead ends should be avoided wherever possible, see Figure A1.

Establishing the level of risk to the occupants will provide a starting point for the design. While it is straightforward to address the risk in a new build, where there is a refurbishment or extension of an existing building, reliable information on the original design and specification of materials and systems critical to the escape plan is essential. Existing buildings were not built to current standards and may have routes for fire spread through hidden areas such as the voids in walls, floors and roofs which may compromise escape. While the basic construction cannot be altered, the fabric and the surface finishes can be upgraded to reduce the probability of fire spread.

Designers need to be aware that from 1 March 2003, regulatory guidance (ADB) has been amended to take into account the adoption of European Standards for Reaction-to-Fire and Fire Resistance. Specifiers will need to be aware of the new tests on a range of constructional materials and combinations that will become available as a result. It should also be noted that there is now a range of standard fire test factors that need to be considered, here the designer may find it useful to refer to BS 6336: 1998 Guide to development of fire tests, the presentation of test data and the role of tests in hazard assessment. DIES Managing School Facilities Guide 6 Fire Safety identifies hazards requiring professional advice and defines such hazardous areas as kitchens, boiler rooms, design and technology spaces, laboratories, preparation rooms and chemical stores which must be enclosed by fire resisting constructions.

There are two distinct components to an escape route

1. travel within the building along an unprotected escape route directly to one of alternative exits or via a protected escape route in one direction to a single exit. The protection comes from a minimum of 30min fire resistance to the construction including the doors.
2. travel from that exit to a place of safety.

The direction of travel within the building can be either horizontally to a stair or the outside or vertically via suitably protected escape stairs. Figure A1 summarises the four most common escape routes in schools.
Escape routes in school buildings

A. Inner room with single exit via access room to enclosed Corridor, if present must have Automatic Fire Detection. Access room must not be a cloakroom, fire here will trap inner room occupants. Avoid inner rooms in new build. A-B = 12m direct or 18m actual travel distance, the maximum direct travel distance from any point in the inner room to a storey exit is 30m or 45m actual travel distance (A-C).

B. Classrooms with single exit into enclosed corridor with alternative exits, see Fig A2. A-C up to 30m direct or 45m actual travel distance, A-B = 12m direct or 18m actual travel distance within classroom; not more than 60 pupils plus staff without a second exit to classroom; FD20(s) smoke stop door at midpoint between the two exits.

C. Classrooms or other rooms with a single exit in one direction only ie in a dead end see Fig A6. A-B = 12m direct or 18m actual travel distance, B-C, to either door must be less than 12m. Maximum number of pupils and staff in ‘dead end’ 60. No room in the ‘dead end’ to contain an inner room, or be an area of high fire risk such as a laboratory. If the dead end portion of a corridor leads to a point where there are alternatives, there is still a danger that smoke might prevent escape. This can be avoided by fitting self-closing fire doors on any dead end corridor longer than 4.5m to separate it from any corridor which provides access, alternative exits or continues past one storey exit to another.

D. Classrooms with a single exit into a corridor with alternative exits but with an open activity area. AFD in activity space will allow removal of cross-corridor doors enclosing activity space and the alternative exit from the room opening directly into the activity area. However, one set of FD20(s) doors will still be required in the corridor to separate the two exits. Activity area can be used as meeting room, computer room etc but not to be a cloakroom. A-B = 12m direct or 18m actual travel distance, if A-C less than 45m actual travel distance. If no AFD provided in activity area or adjacent rooms, cross corridor doors required either side of activity area, rooms opening into activity area should then have alternative escape routes via adjacent room. Maximum number of pupils and staff in activity area is 60.
In all cases the wall and ceiling linings should be National Class ‘O’ or Euroclass B - s3, d2. The corridors should be enclosed with full-height smoke retarding partitions and doors or fire resisting and smoke retarding partitions depending on the application.

**Alternative escape routes** are usually acceptable if they are in directions 90° or more apart (see Figure A5); or they are in directions less than 90° apart, but are separated from each other by fire-resisting construction.

As angle ACB is 90° or more there are alternative routes from C, see Table A1 for maximum distances.

There is no alternative route from D as angle ADB is less than 90°. Nor is there an alternative route from E.

**Figure A5 Alternative escape routes**

Angle ABD should be at least 90° plus 2.5° for each metre travelled in one direction from point C.

CBA or CBD (whichever is less) should be no more than the maximum given for alternative routes and CB should be no more than the maximum distance for travel where there are no alternative routes.

**Figure A6 Travel distance in one direction only from classroom ‘dead end condition’**

Whilst escape from the room of fire origin is not perceived to be a problem with an alert, familiar and/or supervised occupancy; if the room is of a size which demands more than one exit then one or more suitable sized and located alternative exit(s) should be provided to enable the calculated occupancy to escape. Where this is not possible in an existing building and an alternative route exists outside the room there will still be a need to demonstrate that pupils and staff can leave safely. A smoke control system to limit the spread of smoke and combustion gases from burning contents of the space would be a suitable option. The system should not allow the smoke to descend below a minimum height during the time taken for the maximum number of anticipated occupants to leave. Nor should there be any undesirable features such as decorative suspended ceilings, curtains or other items that could fall and slow up those leaving the area or fire fighters entering the building. Guidance documents such as BR 368 or the CIBSE Guide E will be helpful here. The route of travel from the room of fire origin to a place of safety shall be constructed to restrict the spread of smoke, especially taking into account any ductwork for environmental control, even if there are alternative routes available. Where the route is protected because of the lack of an alternative the route shall be additionally constructed to provide fire resistance as described above (Part 4). For limitations on travel distance see Table A1.

When the accommodation incorporates a sleeping risk as in a boarding school, the provisions for escape given in various codes (BS5858: Parts 1 and 11) and the new Guide to Hotels under the Regulatory Reform Order 2002 should be adopted. But these provisions should only be relaxed if for example a risk assessment demonstrates that the alarm system speeds up the movement of the occupants while escaping, a voice alarm may be useful in this context. Note that young people can be notoriously heavy sleepers and difficult to arouse.
Existing and new fire alarm systems should comply with BS 5839 /EN54; older systems may need updating with their location upgraded, guidance should be available from the installer. The designer needs to consider several points, including - How does the fire alarm system interact with the security system? What is the security system? What lighting is provided? (see Part 8.1)

With respect to controlling the risk on escape routes guidance suggests ‘limited travel distances, using enclosing constructions of adequate fire resistance, and where the provision of fire exits, exit and directional signs and possibly emergency escape lighting contribute to a safe route’. Travel distances for schools have traditionally been expressed as a maximum of 18m in one direction and 45m in more than one direction, see Table A1 below. However, it is more useful for the designer to first consider ‘travel time’ based on the risk assessment approach, see BS 7974. For example, in a through-age school catering for all age groups, the designer will need to have an understanding of how long will it take a class of three year olds to leave a building compared to a class of sixteen year olds. The younger ones are more likely to take longer to leave the building than the older ones and provision will need to be made for this difference.

Travel time is affected by the interaction between fire detection, the warning, the likely expected fire development and the quality of the information dispensed to the escaping pupils/people and the physical constraints imposed by the building.

Exclusions on escape routes
Note that spiral stairs and fixed ladders are precluded from use in schools as part of an escape route. (ADK Stairs Ramps and Guards). Similarly, single steps, apart from in doorways, should be avoided on escape routes. Lifts (except fire fighting lifts and for a suitably designed and installed evacuation lift that may be used for the evacuation of disabled people in a fire); portable ladders and throw-out ladders; and manipulative apparatus and appliances: eg fold down ladders and chutes are not deemed to be appropriate.

Provided the above approach to the designs is adopted then the everyday management can be easily dealt with by the school. Escape routes need to be kept free of clutter and the fire behaviour of the controlled linings should not become compromised. Whilst this is primarily a management issue it is recommended that as circulation spaces are ideal for dispensing information the designer may wish to put display material on the escape route which can be behind a transparent cover to hold it in place, see Figure A7. To reduce the effects of vandalism the cover should be of a material such as polycarbonate rather than glass.
The distance is usually associated with the level of risk based on the use made of the space, thus laboratories will be high risk and classrooms low risk.

**Table A1** Guidance to suitable travel distances

<table>
<thead>
<tr>
<th>Direct travel distance</th>
<th>One direction only (m)</th>
<th>More than one direction (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct travel distance within a Classroom or activity area open to a corridor, or any other room not listed below</td>
<td>12 (18)</td>
<td>30 (45)</td>
</tr>
<tr>
<td>Direct travel distance in dead-end protected corridor (2)</td>
<td>12</td>
<td>NA</td>
</tr>
<tr>
<td>Direct travel distance within an open or enclosed corridor – low risk</td>
<td>NA</td>
<td>45</td>
</tr>
<tr>
<td>Direct travel distance within a circulation space – low risk</td>
<td>12 (18)</td>
<td>30 (45)</td>
</tr>
<tr>
<td>Direct travel distance within assembly halls, dining rooms, dual purpose areas, open plan areas, sports halls</td>
<td>12 (18)</td>
<td>30 (45)</td>
</tr>
<tr>
<td>Direct travel distance within a laboratory room – high risk</td>
<td>6 (9)</td>
<td>12 (18)</td>
</tr>
<tr>
<td>Areas with seating in rows</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Direct travel distances from any point in any room or area to a storey exit i.e. the sum of the separate parts of the route subject to the maxima stated for individual areas.</td>
<td>18</td>
<td>45</td>
</tr>
</tbody>
</table>

The figures in brackets indicate the extra travel distance allowed where the internal layout is known. * Previously 24m was allowed in existing buildings or as a way to a final exit. Distances can be modified in the light of information available to escapees, height of ceilings etc, see Part 5.

**Notes:**
1. The dimensions stated in the Table are direct distances. In corridors this is, to all intent and purposes, the actual distance travelled. In other areas the location of partitions or furniture etc. will affect the actual distance travelled.

2. Where the initial dead-end gives access to alternative exits, the overall travel distance to a final exit or exit to a protected stair should include the distance travelled in the dead-end and the distance travelled within any room to access the dead-end.

3. Note that the height of the ceiling will influence the rate of smoke logging and hence the visibility on the escape route, which may allow the longer travel distance.

4. Travel distance is usually associated with the level of risk based on the use made of the space, thus laboratories will be high risk and classrooms low risk.

Schools with more than one exit in a central core should be planned so that storey exits are remote from one another, and so that no two exits are approached from the same lift hall, common lobby or undivided corridor, or linked by any of these. Doors leading to the area between the lifts and stairs should be FD20(s) fire doors; if the area is purely a lift lobby then doors should be as shown in Figure 8 in BS5588: Part 11: 1997.

The numbers of people in a school together with the use of the room or space will determine the number of exits and their width, particularly if the rooms and spaces are used for more than one activity during or outside normal school hours. The capacity should be based on Table A2. Note that regulatory guidance suggests that in a two-storey school with only a single escape stair, there should be no more than 120 pupils plus supervisors on the first
storey and no places of high hazard. Classrooms and storerooms should not open onto this stairway. Storeys above the first floor should only be occupied by adults. Where buildings differ, similar floor area or a reasonable number based on similar use or number of fixed seats can be employed. Once calculated the minimum number of escape routes can be determined using Table A3.

<table>
<thead>
<tr>
<th>Room/Area</th>
<th>Occupant capacity based on floor space factor (m²/person) or design intent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom/Lecture Room/Study Room</td>
<td>Maximum design capacity</td>
</tr>
<tr>
<td>Dining Room</td>
<td>1.0</td>
</tr>
<tr>
<td>Assembly Hall/Dual Purpose Area</td>
<td>0.5</td>
</tr>
<tr>
<td>Sports Hall (not used for assembly)</td>
<td>5.0</td>
</tr>
<tr>
<td>Store Room</td>
<td>30.0</td>
</tr>
<tr>
<td>Office</td>
<td>6.0</td>
</tr>
<tr>
<td>Staff Common Room</td>
<td>1.0</td>
</tr>
<tr>
<td>Dormitory</td>
<td>Maximum design capacity</td>
</tr>
<tr>
<td>Bedroom or Study Bedroom</td>
<td>Maximum design capacity</td>
</tr>
</tbody>
</table>

The width of escape routes is now determined following guidelines laid down in ADM, see Table A4.

<table>
<thead>
<tr>
<th>Direction and width of approach</th>
<th>New buildings (mm)</th>
<th>Existing buildings (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight on (without a turn or oblique approach)</td>
<td>800</td>
<td>750</td>
</tr>
<tr>
<td>At right angles to an access route at least 1500mm wide</td>
<td>800</td>
<td>750</td>
</tr>
<tr>
<td>At right angles to an access route at least 1200mm wide</td>
<td>825</td>
<td>775</td>
</tr>
<tr>
<td>External doors to buildings used by the general public</td>
<td>1000</td>
<td>775</td>
</tr>
</tbody>
</table>

The effective clear width is the width of the opening measured at right angles to the wall in which the door is situated from the outside of the door stop on the door closing side to any obstruction on the hinge side, whether this be projecting door open furniture, a weather board, the door, or the door stop.
Figure A8 Effective clear width and visibility requirements of doors for wheelchair users

The width of escape routes and exits is based on the number of pupils needing to use them and should be at least of the dimensions in Table A5. The width of the smallest of any exit still needs to be wide enough for everyone to leave quickly. In a school the minimum width of a corridor in pupil areas should be 1050mm (1600mm in dead ends). Width of escape stairs should not be less than that of the exit leading onto them; at least 1100mm, and not more than 1400mm, unless there is a central handrail in taller buildings.

<table>
<thead>
<tr>
<th>Table A5</th>
<th>Widths of escape routes and exits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum number of persons</td>
<td>Minimum effective clear width mm</td>
</tr>
<tr>
<td>50</td>
<td>750</td>
</tr>
<tr>
<td>110</td>
<td>850</td>
</tr>
<tr>
<td>220</td>
<td>1050</td>
</tr>
<tr>
<td>More than 220</td>
<td>5 per person</td>
</tr>
</tbody>
</table>

Note: ADM states that regardless of the number of users all corridors should have an effective clear width of 1200mm.

The capacity of stairs and exits will need to be calculated based upon the premise that at least one of the alternatives will become smokelocked and so everyone will have to use the remaining exits.

<table>
<thead>
<tr>
<th>Table A6</th>
<th>Capacity of a stair for simultaneous evacuation of the building</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of floors served</td>
<td>Maximum number of persons served by a stair of width</td>
</tr>
<tr>
<td>1000mm</td>
<td>1100mm</td>
</tr>
<tr>
<td>1.</td>
<td>150</td>
</tr>
<tr>
<td>2.</td>
<td>190</td>
</tr>
<tr>
<td>3.</td>
<td>230</td>
</tr>
<tr>
<td>4.</td>
<td>270</td>
</tr>
</tbody>
</table>

* Should it be necessary to go above four floors the designer is recommended to use guidance in ADB

Phased evacuation

In large schools with several hundred pupils and staff present there may be delays resulting from trying to get everybody out of the building at the same time. As an alternative, phased evacuation should be considered and planned for, as the best way to move vulnerable people out of the building first.
In phased evacuation the first people to be evacuated are all those of reduced mobility and those on the storeys most immediately affected by the fire, usually the floor of fire origin and the floor above. Then, if there is a need to evacuate more people, it is done two floors at a time. This is not a method for every type of building as it depends on the provision (and maintenance) of certain supporting systems such as fire alarms. While it does enable narrower stairs to be installed (see Table A7) and has the practical advantage of reducing disruption in large schools it should be regarded as an alternative to simultaneous evacuation.

<table>
<thead>
<tr>
<th>Maximum number of people in any storey</th>
<th>Stair width mm (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1000</td>
</tr>
<tr>
<td>120</td>
<td>1100</td>
</tr>
<tr>
<td>130</td>
<td>1200</td>
</tr>
<tr>
<td>140</td>
<td>1300</td>
</tr>
<tr>
<td>150</td>
<td>1400</td>
</tr>
<tr>
<td>160</td>
<td>1500</td>
</tr>
<tr>
<td>170</td>
<td>1600</td>
</tr>
<tr>
<td>180</td>
<td>1700</td>
</tr>
<tr>
<td>190</td>
<td>1800</td>
</tr>
</tbody>
</table>

If designing for phased evacuation, all stairways should be approached through a protected lobby or protected corridor at each storey, except a top storey; the lifts should be approached through a protected lobby at each storey; every floor should be a compartment floor; the building should be fitted with an appropriate fire warning system, at least to the L3 standard given in BS 5839: Part 1 Fire detection and alarm systems for buildings, Code of practice for system design, installation and servicing. It may also be useful to consider the installation of a voice alarm system in accordance with BS 5839: Part 8 Code of practice for the design, installation and servicing of voice alarm systems. In any case a communication system will need to be provided to indicate which floors to evacuate first via a Floor Warden system which can also talk to the emergency service(s) at the fire access point.

If the building is particularly tall ie over 30m then it should be protected throughout by an automatic sprinkler system meeting the relevant recommendations of BS 5306: Part 2 Fire extinguishing installations and equipment on premises, Specification for sprinkler systems, ie. the relevant occupancy rating together with the additional requirements for life safety;
APPENDIX B FIRE RESISTANCE

Performance in terms of fire resistance to be met by the various elements of construction, including doors, is determined by reference to the relevant parts of BS476: Parts 20 to 24*, or the European tests BS EN 1363, 1364, 1365, 1366, 13831 and 1634 which are all classified by BS EN 13501.

Fire resistance is determined by resistance to collapse (loadbearing capacity) denoted \( R \) in the European classification; resistance to fire penetration (integrity) denoted \( E \) in the European classification; and resistance to the transfer of excessive heat (insulation) denoted \( l \) in the European classification as appropriate to the element under consideration. These notations for the criteria are used throughout, even though test evidence may be generated by the British Standard method.

For assembly type occupancies the minimum periods (min) of structural fire resistance are expressed as loadbearing capacity (R) are given in Table B 1.

<table>
<thead>
<tr>
<th>Table B 1 Loadbearing capacity (R) of elements of structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>School buildings</td>
</tr>
<tr>
<td>Not sprinklered</td>
</tr>
<tr>
<td>Sprinklered</td>
</tr>
<tr>
<td>Boarding school</td>
</tr>
</tbody>
</table>

*Test evidence from BS476: Part 8 unsuitable unless the test was performed before 1981

** Increases to a minimum of 60min for compartment walls separating buildings

Note: 'Sprinklered' means that the building is fitted throughout with an automatic sprinkler system meeting the relevant recommendations of BS 5306 Fire extinguishing installations and equipment on premises. Part 2 Specification for sprinkler systems; ie the relevant occupancy rating together with the additional requirements for lift safety.

Buildings with the top floor more than 30m above ground are not permitted unless sprinklered, then the minimum period of fire resistance is 120 min. Buildings above 18m will also require a fire-fighting shaft similarly protected. Where one structural element supports another then the fire resistance should be the same with minor exceptions, see regulatory guidance in box.

Regulatory guidance sets out criteria for suspended ceilings that contribute to the fire resistance of a floor:

\[
\text{Where suspended ceilings contribute to the fire resistance of a floor and the floor is of a 60 min fire resistance or less, then the suspended ceiling should be Class 0 (National) or Class A2-s3, d2; Class B-s3, d2 or Class C-s3,d2 (European).}
\]

It is quite acceptable for a designer to use information on fire tested elements from manufacturers and trade associations. For example, the Association for Specialist Fire Protection and the Steel Construction Institute Fire Test Study Group published Fire Protection for structural steel in buildings in 1992.

Flame spread over wall and ceiling linings is controlled under National Classifications (Class 1-4) as 'surface spread of flame' under BS 476: Part 7:1971. The European classifications under BS EN 13501-1:2002 classify materials from A1-F plus the indicators s3 d2 where there is no limit set for smoke production and/or flaming droplets/particles.

Class 0 is the highest National product performance for lining materials. This means they are of limited combustibility, Class 1 when evaluated by BS 476: Part 7: 1997, and have a fire propagation index (I) of not more than 12 and sub index (i) of not more than 6 as tested under BS 476:Part 6:1981 or 1989. Note that Class 0 is called up under Building Regulations and is not a classification in any British Standard test.

Although proprietary information is available from manufacturers the designer must ensure that the surface spread of flame rating of a material or product has been carefully checked for suitability, adequacy and applicability to the construction to be used. Note that small differences in detailing, such as thickness, substrate, colour, form, fixing, adhesive etc, may significantly affect the rating.

Roof coverings are designated AA, AB or AC depending on the results of BS476: Part 3: 1958. There is currently no classification procedure on DD ENV 1187:2002 so the National test is the one to apply.

Reaction-to-fire tests now classify products, including flooring as 'A1,A2, B,C,D,E or F' with F being the lowest performance in BS EN 13501-1:2001. Class A1 is non-combustible; the National classes are from the results of BS476: Part 4:1970, or Part 11: 1982. Limited combustibility materials are those tested in BS476: Part 11:1982, or achieving A2-s3, d2 in BS EN 13501-1:2002. The new ADB also includes composite products such as plasterboard which should meet any appropriate flame spread rating when used as an exposed lining.

### Application of the fire resistance standards in Table B 1

<table>
<thead>
<tr>
<th>a.</th>
<th>Where one element of structure supports or carries or gives stability to another, the fire resistance of the supporting element should be no less than the minimum period of fire resistance for the other element (whether that other element is loadbearing or not).</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>There are circumstances where it may be reasonable to vary this principle, for example where the supporting structure is in the open air, and is not likely to be affected by the fire in the building; or the supporting structure is in a different compartment, with a fire separating element (which has the higher standard of fire resistance) between the supporting and the separated structure; or where a plant room on the roof needs a higher fire resistance than the elements of structure supporting it.</td>
</tr>
<tr>
<td>b.</td>
<td>Where an element of structure forms part of more than one building or compartment, that element should be constructed to the standard of the greater of the relevant provisions.</td>
</tr>
<tr>
<td>c.</td>
<td>Although most elements of structure in a single storey building may not need fire resistance, fire resistance will be needed if the element is part of (or supports) an external wall and it is necessary to limit the extent of openings and other unprotected areas in the wall; or is part of (or supports) a compartment wall, including a wall common to two or more buildings; or supports a gallery.</td>
</tr>
</tbody>
</table>
APPENDIX C CONSTRUCTION AS A MEANS TO CONTAIN A FIRE

C.1 Regulatory compartmentation recommendations

Compartment walls and compartment floors should be provided in the circumstances described in Table C1, with the proviso that the lowest floor in a building does not need to be constructed as a compartment floor. Information on the requirements for compartment walls and compartment floors in different circumstances is given below. Provisions for the protection of openings in compartment walls and compartment floors are given in Part C7 below.

<table>
<thead>
<tr>
<th>Table C1 Provision of compartment walls and floors</th>
</tr>
</thead>
<tbody>
<tr>
<td>The following should be constructed as compartment walls and floors in school buildings:-</td>
</tr>
<tr>
<td>1. Any floors or walls bounding a protected shaft</td>
</tr>
<tr>
<td>2. Every floor in the school should be a compartment floor; this avoids the need for compensatory fire suppression systems unless the building is over 30m in height.</td>
</tr>
<tr>
<td>3. A wall which is common to two or more buildings.</td>
</tr>
<tr>
<td>4. Any wall needed to sub-divide the school into sub-compartment not exceeding 2000m² if sprinklered.</td>
</tr>
<tr>
<td>5. All floors in a building or part of a building containing flats, study bedrooms or dormitories and used for residential purposes.</td>
</tr>
<tr>
<td>6. All walls enclosing individual flats, study bedrooms or dormitories, including the walls between such units of accommodation and between the units and any common access corridor or lobby, and between the units and any other area e.g. a communal kitchen.</td>
</tr>
<tr>
<td>7. Any wall separating residential accommodation from any part of the same building which is being used for other purposes eg teaching.</td>
</tr>
</tbody>
</table>

Every compartment wall and compartment floor should satisfy the following:

a) form a complete barrier to fire between the compartments that they separate, satisfying the same criteria throughout
b) have the appropriate fire resistance as indicated in Table C1
c) walls in a top storey beneath a roof should be continued through the roof space
d) the fire resistance of the compartmentation should be maintained where any compartment wall/floor/roof/external wall meet
e) a compartment wall should be taken to meet the underside of a roof covering or deck and should also be continued across any eaves cavity

If a fire penetrates a roof near a compartment wall there is a risk that it will spread over the roof to the adjoining compartment. To reduce this risk, a zone of the roof 1500mm wide on either side of the wall should have a covering of designation AA, AB or AC (see Table C2) on a substrate or deck of a material of limited combustibility. Note: double-skinned insulated roof sheeting should incorporate a band of material of limited combustibility, within the void in the zone immediately above the wall.

In school buildings less than 15m high, combustible boarding used as a substrate to the roof covering, wood wool slabs or timber tiling battens, may be carried over any compartment wall provided that they are fully bedded in mortar or other suitable material over the width of the wall. The possibility of the roof ‘see-sawing’ as a result of collapse on one side of the wall, which could dislodge the seal, must be considered in the design and prevented where necessary.

Notional designations of the grading of roof materials is shown in Table C2.
Table C2 Notional designations of roof coverings

Part 1. Pitched roofs covered with slate or tiles

<table>
<thead>
<tr>
<th>Covering material</th>
<th>Supporting structure</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Natural slates</td>
<td>timber rafters with or without underfelt</td>
<td>AA</td>
</tr>
<tr>
<td>2. Fibre reinforced cement slates</td>
<td>sarking, boarding, woodwool slabs, compressed</td>
<td></td>
</tr>
<tr>
<td>3. Clay tiles</td>
<td>straw slabs, plywood, wood chipboard, or fibre</td>
<td></td>
</tr>
<tr>
<td>4. Concrete tiles</td>
<td>insulating board</td>
<td></td>
</tr>
</tbody>
</table>

Note: Although the table does not include guidance for roofs covered with bitumen felt, it should be noted that there is a wide range of materials on the market and information on specific products is readily available from manufacturers.

Part 2 Pitched roofs covered with self supporting sheet

<table>
<thead>
<tr>
<th>Roofing covering material</th>
<th>Construction</th>
<th>Supporting structure</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5. Profiled sheet of galvanised steel,</td>
<td>single skin without underlay with underlay or</td>
<td>structure of timber, steel or concrete</td>
<td>AA</td>
</tr>
<tr>
<td>aluminium, fibre reinforced cement, or</td>
<td>plasterboard fibre insulating board or woodwool</td>
<td></td>
<td></td>
</tr>
<tr>
<td>pre-coated (coated) steel or aluminium</td>
<td>slab</td>
<td></td>
<td></td>
</tr>
<tr>
<td>with PVC or PVF2 coating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. as in 5 above</td>
<td>double skin without interlayer, as in 5 above</td>
<td>as in 5 above with interlayer of resin bonded</td>
<td>AA</td>
</tr>
<tr>
<td></td>
<td>or with interlayer of glass fibre, mineral wool</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>slab, polystyrene or polyurethane</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part 3 Flat roofs covered with bitumen felt

A flat roof comprising of bitumen felt should (irrespective of the felt specification) be deemed designation AA. If the felt is laid on a deck constructed of 6mm plywood, 12.5mm wood chipboard, 16mm (finished) plain edged timber boarding, compressed straw slab, screeded woodwool slab, profiled fibre reinforced cement or steel deck (single or double skin) with or without fibre insulating board overlay, profiled aluminium deck (single or double skin) with or without fibre insulating board overlay, or concrete or clay pot slab (in situ or precast) and has a finish of:

a. bitumen-bedded stone chippings covering the whole surface to a depth of at least 12.5mm;

b. bitumen-bedded tiles of a non-combustible material;

c. sand and cement screed; or

d. macadam.

Part 4 Pitched or flat roofs covered by fully supported material

<table>
<thead>
<tr>
<th>Covering material</th>
<th>Supporting structure</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Aluminium sheet</td>
<td>Timber joists and:</td>
<td>AA*</td>
</tr>
<tr>
<td>2. Copper sheet</td>
<td>tongued and grooved boarding</td>
<td></td>
</tr>
<tr>
<td>3. Zinc sheet</td>
<td>or plain edged boarding</td>
<td></td>
</tr>
<tr>
<td>4. Lead sheet</td>
<td>Steel or timber joists with deck of:</td>
<td>AA</td>
</tr>
<tr>
<td>5. Mastic asphalt</td>
<td>woodwool slabs, compressed straw slab</td>
<td></td>
</tr>
<tr>
<td>6. Vitreous enamelled steel</td>
<td>wood chipboard, fibre insulating board,</td>
<td></td>
</tr>
<tr>
<td>7. Lead/tin alloy coated steel sheet</td>
<td>or 9.5mm plywood</td>
<td></td>
</tr>
<tr>
<td>8. Zinc/aluminium alloy coated steel sheet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Pre-painted (coated) steel sheet</td>
<td>Concrete or clay pot slab (in situ or precast)</td>
<td>AA</td>
</tr>
<tr>
<td>including liquid-applied PVC coatings</td>
<td>or non-combustible deck of steel, aluminium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>or fibre cement (with or without insulation)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Lead sheet supported by timber joists and plain edged boarding equivalent to a designation of BA

The designer must also consider the penetrations through compartment boundaries which should be of fire-resisting construction. Generally speaking these will be in the form of services routed through the building, see C8 for specifications.

Cavity barriers within concealed spaces will prevent unseen spread of smoke and hot gases. They should be positioned at any junction of cavities in external or stairway walls, floors or roofs where they coincide with compartment walls or walls designed to restrict disproportionate damage. This will isolate risks or protect assets and should satisfy the integrity and insulation criteria of the standard. Cavity barriers can be as far apart as 40 m but it is recommended that in schools they should also reflect the position of walls/separate activities above or below them. This may be especially important in ceilings over assembly halls and other large spaces such as sports halls; further, under floor barriers may be needed to prevent the transmission of sound horizontally, see Approved Document E and DIIS Building Bulletin 93 ‘Acoustics in Schools’. Cavities of any size should not have linings of Class 4 Surface Spread of Flame rating. Roof cavities may need ventilating and eaves or roof ventilators should be considered that will not compromise any cavity barriers present.
The maximum dimensions of compartments within schools are given in Table C3. If there is a special fire hazard present, then it should be enclosed with fire resisting construction with a minimum provision of REI 60, see table below.

<table>
<thead>
<tr>
<th>Table C3 - Maximum dimensions of compartments within schools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Floor area of any one storey in the school or any one storey in a compartment (m²)</td>
</tr>
<tr>
<td>In multi-storey schools</td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td>Not sprinklered</td>
</tr>
<tr>
<td>Sprinklered</td>
</tr>
</tbody>
</table>

Note: ‘Sprinklered’ means that the school is fitted throughout with an automatic system meeting the relevant recommendations of BS 5306: Part 2 i.e. the relevant occupancy rating plus requirements for ‘life safety’. The benefit to the designer from the installation of such a suppression system is that compartments can be more than double in size.

C2 Construction of protected escape routes or separated areas

Protected stairways and corridors are used in the early stages of a fire, in most cases, even before the fire has reached a fully developed state. Protected stairs that are in daily use will be the main way out of the building. There is no point in building alternative staircases that are only used in an emergency. Where new build is being designed, typically, at least two protected stairways should be included. Where refurbishment is being done then there is much to be gained from lining the stairway with material that is at least of limited combustibility. Smoke may enter the protected stair as it is used during the evacuation.

Thus the primary requirement of the construction used for such routes is smoke tightness. All doors opening onto protected routes shall be fitted with smoke seals and the complete door assemblies should be able to demonstrate that they restrict the leakage of ambient temperature of smoke to 3m³/m²/hr when tested in accordance with BS476 : Part 31: Section 31.1: 1983 / ISO 5925/1, “Methods for measuring smoke penetration through doorsets and shutter assemblies - Method of measurement under ambient temperature conditions”, at a pressure of 25Pa. This method tests the whole door leaf in its frame plus the hardware as it will be used in the school. Leakage paths are through the main frame door gap, and through interruptions to the seal at hinges and latches; ‘through piercings’ such as handle spindles and gaskets around glazed areas can allow smoke to leak through as they may interrupt the smoke seal and cause an increase in the measured leakage rate. The seal should be shown to be durable and, when fitted correctly, have a low enough frictional resistance to allow the door to close fully without undue pressure being exerted by the door closer.

NOTE:   
Door closing devices should not have an opening moment in excess of the following values unless the doors are held open on electro-magnetic hold-open devices:

infants and juniors ≤ [10] years and disabled - (36) Nm

pupils ≥ [10] years - (47) Nm

In addition to the fitting of smoke seals designed to reduce the leakage of ambient temperature smoke, the door leaf/frame/meeting stile junction shall also incorporate an intumescent seal to reduce the ingress of warm/hot smoke.

In order for the whole of the protected route to have a similar level of ‘smoke tightness’ all joints between structural elements shall be fully sealed either by means of a plaster skim coat or by means of a flexible sealant or suitable elastomeric gasket. Any ducts passing through fire-resisting constructions should be fitted with dampers. All glazed apertures shall be sealed
around their perimeter with a bead of suitable sealant or with a fire-tested tightly fitted elastomeric glazing gasket. The glass shall comply with the recommendations given below in 4.2.5.

All elements forming these protected routes, e.g. walls, doors, glazed screens/partitions shall have the fire resistance given below when evaluated with respect to BS476: Part 21 or 22: 1987; or its European equivalent BS EN 13501, 1363, 1364, 1365, 1366, 13831 and 1634 when implemented, except those that form part of the structural frame, see Table 8.

<table>
<thead>
<tr>
<th>Element</th>
<th>Fire Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R - Loadbearing capacity</td>
<td>30 minutes *(A)</td>
</tr>
<tr>
<td>E - Integrity</td>
<td>30 minutes</td>
</tr>
<tr>
<td>I - Insulation</td>
<td>15 minutes *(B)</td>
</tr>
</tbody>
</table>

*(A) Loadbearing capacity is only required for those walls that are loadbearing in use.
*(B) An alternative to the element providing a 15 minute integrity rating is that at 15 minutes the heat flux measured at a distance of 1m (in the corridor or stair) shall not exceed [15]kW/m², or glasses which are non-insulated are used in limited areas (see Table 3)

- per metre of the length of the gap between the leaf and the frame including the threshold [not sure this is in quite the right place]

Any services or ductwork passing through the elements forming the protected routes shall be sealed between the duct walls and associated construction to maintain integrity for 30 minutes which takes into account the anticipated distortion of the elements and service in the hot state. Because of the need to keep the protected route clear of smoke the specified penetration sealing system or gasket should be impermeable. The ductwork itself should comply with the guidance given below as appropriate for the application.

**C3 Protection of key facilities and isolation of high hazards**

The protection of key facilities such as boiler rooms and computer rooms, or the isolation of those areas identified as high hazards, will require the fire protection to be maximised to control the risk. High hazards are in laboratory, preparation areas, design and technology spaces, kitchens, boiler rooms and where hot works are actually carried out. As such, all elements forming the enclosure containing the hazard or equipment to be protected shall have the following fire resistance when evaluated with respect to BS476: Part 21 22: 1987; or its European equivalent BS EN 13501, 1363, 1364, 1365, 1366, 13831 and 1634 when implemented.

<table>
<thead>
<tr>
<th>Element</th>
<th>Fire Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>R - Loadbearing capacity</td>
<td>60 minutes *(C)</td>
</tr>
<tr>
<td>E - Integrity</td>
<td>60 minutes</td>
</tr>
<tr>
<td>I - Insulation</td>
<td>60 minutes</td>
</tr>
</tbody>
</table>

*(C) Where constructions are used that exhibit significant deflections when heated it will be necessary to specify fire resistance with limiting deflections rather than the maximum loadbearing capacity. The ability of the construction to accept significant deflections during a fire may compromise its fire separation from adjacent areas.

Where there is the potential for rapid smoke production or the equipment is vulnerable to smoke contamination then the use of smoke seals should be considered.

Any ductwork or service ducts that pass between the isolated area and the rest of the school shall be fitted with fire and smoke dampers at the point at which they pass through the elements bounding the enclosure. Design engineers should look for alternative routes for services so as to minimise the effect on compartments.

**C4 Protection to restrict disproportionate damage**

Whether elements of construction have a direct bearing on life safety or not, it is recommended that all of them should either have a minimum level of fire resistance or that
the school is designed with a series of sub-compartment. They should be designed so that no facilities critical to the running of the school can be destroyed by a fire starting elsewhere in the building. Further, the loss from a fire should be restricted to 25% of the volume/area of the school. The elements selected to create the sub-compartment should be designed to provide not less than the following performance levels

<table>
<thead>
<tr>
<th>Specification</th>
<th>Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loadbearing capacity</td>
<td>30 minutes <em>(D)</em></td>
</tr>
<tr>
<td>Integrity</td>
<td>30 minutes <em>(E)</em></td>
</tr>
<tr>
<td>Insulation</td>
<td>30 minutes <em>(E)</em></td>
</tr>
</tbody>
</table>

*(D)* Loadbearing capacity is only required for those elements that are loadbearing in use

*(E)* An alternative to the element providing a 30 minute integrity rating is that at 30 minutes the heat flux measured at a distance of 1m on the protected side shall not exceed [15] kW/m²

As with elements designed to isolate special risks, the influence that deflection may have on any element designed to reduce disproportionate damage should be considered and where it may compromise performance, the measures shall be introduced to restrict the influence.

**SPECIFIC GUIDANCE**

The guidance given above relates to the general performance levels for the primary elements of structure. Many contemporary forms of construction require a greater understanding of the technology involved if they are to achieve their potential performance. The following clauses amplify the above recommendations

**C5 Robust constructions**

By the nature of the activities that go on within a school and the exuberance of youth, the elements of construction making up a school should be able to withstand more abuse than those incorporated in the normal environment. This is particularly true in areas within the building that are used for physical training, sports or play. Guidance on the selection of products that are deemed to be robust can be found in Table C4.

Similarly, many modern materials used in the construction of fire resisting barriers are sensitive to both installation, maintenance and careful use in practice. Non-robust and use-sensitive products should only be used with caution and attention is drawn to the following issues:

- all walls and glazed screens used in the construction of pedestrian routes shall satisfy the criteria for impact strength ie Class A, BS 6180: 1999
- all glass used in the construction of fire walls in schools should be classed A or B in accordance with BS6206: 1981
- all fire separating walls should, as well as providing the rating specified above, be rated at least heavy duty (HD) when evaluated by BS 5234: Part 2; 1992 Specification for performance requirements for strength and robustness, and should be installed in accordance with Part 1 of BS 5234
- monolithic, unwired fire resisting glasses should not be used unless they can accept an edge cover of not less than 15mm in metal or timber glazing systems
- fire resisting timber door assemblies shall not be less than 44mm thick and shall be constructed with facings of chipboard or plywood not less than 6mm thick.

The Summary in Table C4 gives some guidance on the selection of robust materials that could be used for fire separating walls and floors used in the construction of indoor sports or play areas to give sufficient resistance to impact and other mechanical damage.
### Table C4 Summary of the materials for use in the construction of robust fire separating constructions

<table>
<thead>
<tr>
<th>PRODUCT DESCRIPTION</th>
<th>DIMENSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brick and blockwork</strong></td>
<td>Density not less than 600kg/m$^3$ and not less than 100mm thick*.</td>
</tr>
<tr>
<td></td>
<td>* Subject to a slenderness ratio (thickness/height) not less than 0.025.</td>
</tr>
<tr>
<td><strong>Studs</strong></td>
<td></td>
</tr>
<tr>
<td>timber</td>
<td>&gt;47mm x 89mm softwood &gt;400kg/m$^3$</td>
</tr>
<tr>
<td>steel</td>
<td>&gt;50mm x 150mm mild steel channel or Z section - 1mm thick</td>
</tr>
<tr>
<td><strong>Joists</strong></td>
<td></td>
</tr>
<tr>
<td>timber</td>
<td>&gt;47mm x 225mm softwood &gt;400kg/m$^3$</td>
</tr>
<tr>
<td>steel</td>
<td>&gt;70mm x 250mm mild steel - 1mm thick</td>
</tr>
<tr>
<td><strong>Boards/Linings</strong></td>
<td></td>
</tr>
<tr>
<td>Gypsum level</td>
<td></td>
</tr>
<tr>
<td>Plasterboard</td>
<td>19mm thick as a single layer</td>
</tr>
<tr>
<td></td>
<td>12mm thick as part of a multiple layer</td>
</tr>
<tr>
<td>Reinforced plasterboard</td>
<td>15mm thick as a single layer</td>
</tr>
<tr>
<td></td>
<td>10mm thick as part of a multiple layer</td>
</tr>
<tr>
<td>Glass reinforced Gypsum</td>
<td>12mm as a single layer</td>
</tr>
<tr>
<td></td>
<td>9mm thick as part of a multiple layer</td>
</tr>
<tr>
<td><strong>Calcium silicate based</strong></td>
<td></td>
</tr>
<tr>
<td>Flexural strength (dry) 5-7.5 (N/mm$^2$)</td>
<td>15mm as a single layer</td>
</tr>
<tr>
<td>Flexural strength (dry) 5-7.5 (N/mm$^2$)</td>
<td>10mm thick as part of a multiple layer</td>
</tr>
<tr>
<td>Flexural strength (dry) 7.5 (N/mm$^2$)</td>
<td>12mm as a single layer</td>
</tr>
<tr>
<td></td>
<td>9mm as part of a multi-layer system</td>
</tr>
<tr>
<td><strong>Composite Boards</strong></td>
<td></td>
</tr>
<tr>
<td>Gypsum based chipboard</td>
<td>15mm as a single layer</td>
</tr>
<tr>
<td></td>
<td>10mm as part of a multi-layer system</td>
</tr>
<tr>
<td>Cement based chipboard</td>
<td>12mm as a single layer</td>
</tr>
<tr>
<td><strong>Fire resisting glazing</strong></td>
<td></td>
</tr>
<tr>
<td>Wired glass (fire and safety)</td>
<td>6mm</td>
</tr>
<tr>
<td>Laminated fire resisting glass</td>
<td>12mm or greater</td>
</tr>
<tr>
<td>Solid fire resisting monolithic glasses</td>
<td>10mm thick or greater</td>
</tr>
<tr>
<td><strong>Fire resisting doors</strong></td>
<td></td>
</tr>
<tr>
<td>FD30</td>
<td>i) Solid laminated timber cores with facings of chipboard, mdf or plywood not less than 4mm thick (total thickness &gt;44mm).</td>
</tr>
<tr>
<td></td>
<td>ii) Flaxboard cores with a flaxboard density of not less than 400kg/m$^3$ with softwood framing not less than 42mm face width and with density of greater than 510kg/m$^3$ when</td>
</tr>
</tbody>
</table>
dry. Facings to be high density chipboard, plywood or mdf not less than 6mm thick.

FD60

i) Solid laminated timber cores with facings of chipboard, plywood [6mm] thick (total thickness >53mm).

ii) Mineral board cores with facing of chipboard or plywood [6mm] thick (total thickness >50mm).

Smoke Seals

i) Blade seals where the blade is co-extruded with the intumescent seal or any sleeve to contain intumescent seals.

ii) Compression seals fitted tight into the rebate of the frame reveal preferably being compressed by both the face and the leaf edge.

C6 Glazed constructions

Glazed elements, when incorporated into walls, partitions and screeds which are required to be fire resisting, will generally need to provide a level of fire resistance (when tested in accordance with BS476: Part 22: 1987) equivalent to that of the structure into which they are installed.

In all cases the integrity of the construction will be the same as the wall it is installed in, but the level of insulation will be dictated by the function of the wall, i.e. whether it is forming a protected route, isolating a hazard, or forming part of the property protection measures.

To minimize the risk of ignition of adjacent floorings or floor coverings by direct conduction, non-insulating glazed areas in fire resisting structures should be at least 100mm above floor level.

It should be noted that there are many different proprietary types of fire resisting glass available, many of them with similar sounding names. The main glass types are as follows;

- Non-insulating glasses  
  - integral wired glass  
  - laminated wired glass  
  - monolithic ‘borosilicate’ glass  
  - monolithic ‘soda-lime’ glass  
  - laminated wired glass  
  - laminated clear ‘soda-lime’ glass  
  - ceramic glass  
  - laminated safety ceramic glass

- Insulating glasses  
  - intumescent multi-laminated soda-lime glass  
  - intumescent ‘gel-filled’ glass

- Partially insulating glasses  
  - intumescent laminated glass

- Radiation control glasses  
  - coated monolithic ‘soda-lime’ glass

The glazing system requirements for these glasses are very different and any change in the glass type without a change in the glazing system has the potential to reduce the
performance to, in many cases, 10% of the required level, i.e. 3 minutes instead of 30 minutes. It is critical that the method of installation and the material and design of the construction being glazed is in full conformity with the glass manufacturer's recommendations. All of the above glass types will have test evidence, but some of it will be strictly related to one glazing system material. A significant number of the listed glass types, either do not have any certification in timber frames or doors, or else it is very limiting. Some information on the compatibility of glass and glazing systems can be found in the IFSA Information Sheet No. 2.

The maximum pane size suitable for use in any proposed system should be determined by testing in accordance with BS476: Part 22: 1987, or alternatively assessed by a suitably qualified person.

There is little information available on the fire resistance of panes in frames other than rectangular. However, the performance of different shapes of glass should be taken to be that of a known shape of equivalent area.

Evidence of performance on single panes of glass should not be assumed to be relevant when considering a multiple paneled situation and alternative test or assessment evidence in support of the proposed configuration should be sought.

The performance of most fire resisting glazed systems has been confirmed by testing in the vertical position only. If vertically tested systems are to be used in either an inclined or horizontal panel their performance under fire test conditions will be significantly reduced. In such situations assessments from qualified people will need to be obtained.

![Figure C1](image1.png)  
**Figure C1** Care in specification and fitting of glazing is important

**C7 Fire doors and fire door/builders hardware**

Fire doors are one of the most important components in a compartmentation, hazard isolation strategy, and yet, by their very nature they are very vulnerable to both mis-management and abuse. Care in their selection to ensure that they are adequate for their purpose cannot be over stated.

The door of any doorway or exit should, if reasonably practicable, be hung to open in the direction of escape, and should always do so if the number of persons that might be expected to use the door at the time of a fire is more than 60. All doors on escape routes should be hung to open not less than 90 degrees, and with a swing that is clear of any change of floor level, other than a threshold or single step on the line of the doorway and does not reduce the effective width of any escape route across a landing. A door that opens towards a corridor or a stairway should be sufficiently recessed to prevent its swing from encroaching on the effective width of the stairway or corridor. Doors should be hung so as to ensure a good fit to the frame when closed and it is important that the frame to wall joint is adequately sealed. The ability of the fire doors to perform their designed function will depend upon their being
fully closed at the time of a fire. They are therefore normally required to be fitted with self-closing devices.

In general, doors on escape routes (whether or not the doors are fire doors), should either not be fitted with lock, latch or bolt fastenings, or they should only be fitted with simple fastenings that can be readily operated from the side approached by people making an escape. The operation of these fastenings should be readily apparent and without the use of a key and without having to manipulate more than one mechanism. This is not intended to prevent doors being fitted with hardware to allow them to be locked when the rooms are empty. There may also be situations such as bedrooms in boarding schools, where locks may be fitted that are operated from the outside by a key and from the inside by a knob or lever etc. Lever door openers are preferred as they are easier for small or handicapped hands to use.

Failure of doors under fire condition usually occurs either at the gap between the door and the frame, or at one or more of the points where ironmongery is fixed (particularly at the hinges or lock positions) or, in the case of glazed doors, at the line of the junction between the glazed area and the rest of the door.

Fire doors are prone to deflection/distortion when heated on one face and it is this movement that often generates the gap that results in failure. There are many factors that influence the size of such gaps,

- height and width of the leaf
- hardware restraint, or lack of it
- intumescent seal restraint, type and size
- configuration of assembly, one leaf/two leaf
- double action, single action
- size and position of glazed openings

It is vital that the importance of these measures are recognised and the evidence in support of the doorsets, whether by test or a Field of Application Assessment, is for the ‘as to be installed’ assembly. A failure to do so could result in up to 60% of the performance being lost as differential movement of the leaves relative to the frame occurs early in the fire exposure.

Vision panels are needed where doors on escape routes sub-divide corridors, or where any doors are hung to swing both ways, but note also the provision in Approved Document M Access and facilities for disabled people, concerning vision panels in doors across accessible corridors and passageways and the provisions for the safety of glazing in Approved Document N Glazing - safety in relation to impact, opening and cleaning. Note that ADM suggests that vision panels should be between 500mm and 1500mm from the floor, see Figure A8.

The performance of a fire door when tested in accordance with BS476: Part 22: 1987 is judged by its time to failure (in minutes) for each of the criteria of ‘integrity’ and ‘insulation’, however, requirements and recommendations made in connection with regulations and codes of practice do not normally specify or recommend any performance for ‘insulation’.

For the purposes of this code, fire doors are designated by reference to their required performance (in minutes) for integrity only, e.g. a reference FD20 implies that the door in that situation should achieve not less than 30 minutes integrity, when tested in accordance with BS476: Part 22: 1987. Where doors are also required to control the passage of smoke at ambient temperature, the suffix ‘S’ is added.

Although the above-mentioned system of designation specifically excludes any reference to performance with respect of insulation properties, this code recommends limits to the extent of the non-insulating glazed areas in fire doors in certain positions because of the problems of radiation through traditional fire resisting glass. Non-insulated fire doors of a metallic construction can present similar hazards to persons attempting to escape from the complete surface of the door.
There is no scientific reason for incorporating rebated meeting stiles and these should be deprecated in favour of smoke sealed plain edges. Designers and specifiers should refer to codes of practice relating to the construction, hardware and the installation of fire doors, such as BS 8214.

In schools security on final exit doors is an important consideration. To overcome this problem the use of emergency escape latches and panic bars/bolts on such doors is acceptable. If linked to an alarm system as well there will be the added benefit of preventing abuse.

The use of smoke control door assemblies can enhance the life safety provisions within a school significantly, the benefit of which becomes increasingly important when sleeping accommodation is incorporated. Smoke sealed doors restrict the flow of the products of combustion, most of which are acidic, and hence corrosive, and this has the capability of reducing the potential damage that a fire can cause.

The British Standard test for smoke control door assemblies, BS 476: Part 31.1: 1983 determines the ability of a door assembly to restrict the flow of cold smoke. There is no method by which the ability of a door assembly to restrict the spread of hot smoke can be established, but it is recognised by most practitioners just how much of an improvement an intumescent seal makes to this aspect of the performance. Regulatory guidance only recommends sealing the head and jambs of a door assembly for purely pragmatic reasons. Where the fire separated area has the potential to generate high smoke volumes or where the protected space is particularly sensitive to smoke/acid attack, consideration should be given to using ‘drop’ smoke seals on the threshold of these doors.

Smoke seals are vulnerable to both accidental damage and vandalism and therefore smoke seals that are ‘robust’ are preferred over those that are more readily abused (see Table 16)

Table C5 summarises the provisions for fire doors.

<table>
<thead>
<tr>
<th>Table C5 Provision for fire doors in school buildings</th>
<th>Minimum fire resistance of door in terms of integrity (minutes) when tested to BS 476 part 22(1)</th>
<th>Minimum fire resistance of door in terms of integrity (minutes) when tested to the relevant European standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provision of door</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. In a compartment wall separating buildings.</td>
<td>As for the wall in which the door is fitted, but a minimum of 60</td>
<td>As for the wall in which the door is fitted, but a minimum of 60</td>
</tr>
<tr>
<td>2. In a compartment wall:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. If it separates a flat or maisonette from a space in common use;</td>
<td>FD 30S (2)</td>
<td>E30 Sₐ (3)</td>
</tr>
<tr>
<td>b. Enclosing a protected shaft forming a stairway situated wholly or partly above the adjoining ground;</td>
<td>FD 30S (2)</td>
<td>E30 Sₐ (3)</td>
</tr>
<tr>
<td>c. Enclosing a protected shaft forming a stairway not described in (b) above;</td>
<td>Half the period of fire resistance of the wall in which it is fitted, but 30 minimum and with suffix S(2)</td>
<td>Half the period of fire resistance of the wall in which it is fitted, but 30 minimum and with suffix Sₐ(3)</td>
</tr>
<tr>
<td>d. Enclosing a protected shaft forming a lift or</td>
<td>Half the period of fire resistance of the wall in which it is fitted, but 30</td>
<td>Half the period of fire resistance of the wall in which it is fitted, but 30</td>
</tr>
<tr>
<td>Service shaft;</td>
<td>Minimum</td>
<td>Minimum</td>
</tr>
<tr>
<td>---------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>e. Not described in (a), (b), (c) or (d) above.</td>
<td>As for the wall it is fitted in, but add Sa(2) if the door is used for progressive horizontal evacuation under the guidance to B1</td>
<td>As for the wall it is fitted in, but add Sa(3) if the door is used for progressive horizontal evacuation under the guidance to B1</td>
</tr>
</tbody>
</table>

3. In a compartment floor
As for the floor in which it is fitted
As for the floor in which it is fitted

4. Forming part of the enclosures of:
   a. a protected stairway (except where in item 9); or
   b. a lift shaft (see paragraph 6.42b); which does not form a protected shaft in 2(b), (c) or (d) above.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>FD 30 (S)</td>
<td>E30 S_a (3)</td>
</tr>
<tr>
<td>FD 30</td>
<td>E30</td>
</tr>
</tbody>
</table>

5. Forming part of the enclosure of:
   a. a protected lobby approach (or protected corridor) to a stairway;
   b. any other protected corridor; or
   c. a protected lobby approach to lift shaft (see paragraph 6.42)

<p>| | |</p>
<table>
<thead>
<tr>
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<th></th>
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</thead>
<tbody>
<tr>
<td>FD 30 (S)</td>
<td>E30 S_a (3)</td>
</tr>
<tr>
<td>FD 20 (S)</td>
<td>E20 S_a (3)</td>
</tr>
<tr>
<td>FD 30 (S)</td>
<td>E30 S_a (3)</td>
</tr>
</tbody>
</table>

6. Affording access to an external escape route
FD 30 | E30 |

7. Sub-dividing:
   a. corridors connecting alternative exits;
   b. dead-end portions of corridors from the remainder of the corridor

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>FD 20 (S)</td>
<td>E20 S_a (3)</td>
</tr>
<tr>
<td>FD 20 (S)</td>
<td>E20 S_a (3)</td>
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</table>

8. Any door:
   a. within a cavity barrier

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>FD 30</td>
<td>E30</td>
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9. Any door:
   a. forming part of the enclosure to a protected landing in a flat or maisonette; or
   b. within any other fire resisting construction in a flat or maisonette not described elsewhere in this table

<p>| | |</p>
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>FD 20</td>
<td>E20</td>
</tr>
<tr>
<td>FD 20</td>
<td>E20</td>
</tr>
</tbody>
</table>

Notes:
1. To BS 476: Part 22 (or BS 476: Part 8 subject to regulatory guidance)
2. Unless pressurization techniques complying with BS 5588: Part 4 Fire Precautions in the design, construction and use of buildings Code of Practice for smoke control using pressure differentials are used, these doors should also either:
   (a) have a leakage rate not exceeding 3m³/m²/hour (head and jambs only) when tested at 25 Pa under BS 476 Fire tests on building materials and structures, Section 31.1 Methods for measuring smoke penetration through doors and shutter assemblies, Method of measurement under ambient temperature conditions; or
   (b) meet the additional classification requirement of Sₚ when tested on BS EN 1634-3, Fire resistance tests for door and shutter assemblies, Part 3 - Smoke control doors.

3. The National classifications do not automatically equate with the equivalent classifications in the European column, therefore products cannot typically assume a European class unless they have been tested accordingly.

C8 Linear gaps and penetration sealing systems

C8.1 Fire stopping and linear gap sealing

For fire separation to be effective, there should be continuity at the junctions of the fire resisting elements enclosing a compartment or protected space, and any opening from one fire zone to another should not present a weakness.

Recommendations for fire stopping 'accidental' gaps between various building materials is summarised in Table C6 and provides the most useful guidance on sealant materials. This table defines the use of rigid intumescent sealants (RI), flexible non-intumescent (FN) sealants and flexible intumescents (FI) sealants.

The recommendations made in the table take into account the response to fire of the materials bounding the gap eg whether they erode, shrink, expand, bow and the influence this will have on the seals.

<table>
<thead>
<tr>
<th>Table C6 Recommended product selection for fire stopping gaps (IFSA)</th>
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<tr>
<td><strong>Masonry</strong></td>
</tr>
<tr>
<td>Masonry</td>
</tr>
<tr>
<td>Concrete</td>
</tr>
<tr>
<td>Timber</td>
</tr>
<tr>
<td>Gypsum</td>
</tr>
<tr>
<td><strong>Fire Protected Steel</strong>(3)</td>
</tr>
<tr>
<td><strong>Steel</strong>(1)</td>
</tr>
</tbody>
</table>

(1) restricted to 30min applications
(2) whilst an RI material or FN material can be used, FI would be beneficial
(3) may be non-intumescent if protection does not degrade at all during heating
* treat as a functional linear gap seal

However it must be pointed out that the orientation of the gap will also affect how well the material stays in place and so the choice of product will also need to consider whether it has high or low adhesive qualities and whether the life of the seal can be influenced by the orientation.

The linear gap sealing material should be able to demonstrate by test evidence or assessment that it can maintain the integrity and insulation characteristics of the wall or the floor, or both, at the appropriate gap width, orientation and in the associated construction to be useful in practice.

C8.2 Services passing through fire separating elements

It is inevitable that fire separating walls and floors will be penetrated by services in practice. These services will include metal pipes, plastic pipes, large and small electrical cables, conduits and communication cables. These services shall not compromise the fire resistance
of the element being penetrated and it is important, therefore, to seal the aperture through which the services pass with a sealing system that has been shown by test or assessment to satisfy the integrity and insulation criterion of BS476: Part 20: 1987, in the plane of the element. This evidence of performance shall need to be related to the actual services passing through the wall/floor, e.g. steel pipes, power cables, electrical cables, etc., and should have been generated in conjunction with the same type of associated construction and orientation as in practice. Where the services may come into contact with other combustible services or linings within 0.5m of the unexposed face of the separating element the temperature of the services shall be kept below the permitted maximum temperature rise criterion. The specification of the sealing system shall consider the need to accommodate expansion or deflection of the service, or any support to the service, such as cable trays and ladders, when they are exposed to fire and ensure that the specified system can accommodate any such movement or the movement shall be prevented.

Additional services will inevitably be introduced during the life of the building and the ease of adding new services and sealing them off should be considered in the initial sealing specification.

Where non-metal pipes penetrate the element these shall be fitted with a heat activated closure system where test evidence shows the performance is suitable for the end use. Such devices shall be fixed back to the structure so they will not be readily exposed to fire. Although guidance in support of regulations permits the use of low melting point pipes of up to 40mm diameter to penetrate elements without the use of special sealing devices, solely for life safety purposes, the risk of disproportionate fire and smoke damage to the property and contents must be considered if this option is adopted.

C9 Heating and ventilating ductwork

It is recognised that heating and ventilating ductwork can spread both fire and smoke through the ducts and also compromise the fire resistance of the fire separating walls and floors that they penetrate. To restrict fire and smoke spread through the ductwork follow the recommendations in BS 5588: Part 9. This code recommends the use of dampers where the duct passes through a fire resisting element, unless the duct itself is fire resisting when tested to BS 476: Part 24: 1987 /ISO 6944-1995.

Where dampers are used they should be tested or assessed for fire resistance in accordance with BS ISO 10294-1 and shown to satisfy the criteria of the standard for the duration of the wall/floor being penetrated. Where the damper only satisfies the integrity criterion, and not the insulation criterion, the duct should be insulated for a distance of 0.5m with a suitable fire protection board if there is any possibility of combustible materials coming into contact with the duct in this zone.

When fitting the damper to the wall or floor the method of attachment must take into account the nature of the construction and the likely fire damage. The seal should follow manufacturer’s recommendations allowing for the effects of fire, particularly movement of the duct.

C10 Linings

Linings are capable of influencing the growth and spread of fire, both by contributing to the fire load and propagating fire spread on their surface. For these reasons it is important that the linings to all elements of construction are controlled with respect to the flame spread characteristics.

All designated escape routes, whether protected or not, shall be lined throughout with materials that are of limited combustibility or have a fire propagation indices of $I = 12$ and $i_i = 6$ when evaluated by the method described in BS 476: Part 6: 1989 and have a surface spread of flame rating of Class 1 as measured by BS 476: Part 7: 1997. The performance shall be established for the surface lining material in conjunction with a representative thickness of the substrate material. Escape routes form an integral part of the schools'
circulation routes which makes them important for dispensing information to the pupils by means of notice boards. These notice boards should be confined to routes where there is an alternative means of escape (not in protected routes), kept few in number and, as stated in Section 3, fitted with a cover, preferably top hung so that the cover cannot be left 'jutting-out' into the escape route.

All other linings should have a Class 1 surface spread of flame when evaluated in accordance with BS 476: Part 7: 1989, or BS EN 13501-1:2002 measured on the lining complete with its substrate, unless justified by a functional approach. Notice boards with a surface spread of flame are permitted in classrooms, but these should not extend more than 2.5m without having a break between them of not less than 0.4m. The display material on such notice boards shall not be permitted to build up excessively and they should be managed by the relevant staff.

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