NEBOSH NATIONAL CERTIFICATE IN FIRE SAFETY AND RISK MANAGEMENT

Element 4: Fire protection in buildings

Learning outcomes

On completion of this element, candidates should be able to demonstrate understanding of the content through the application of knowledge to familiar and unfamiliar situations. In particular they should be able to:

4.1 Outline the means of fire protection and prevention of fire and smoke spread within buildings in relation to building construction and design
4.2 Explain the requirements of a means of escape
4.3 Outline the methods and systems available to give early warning in case of fire, both for life safety and property protection
4.4 Outline the selection procedures for basic fire extinguishing methods for both life risk and process risk
4.5 Explain the requirements for ensuring access for the fire service is provided and maintained
4.6 Outline steps to minimise the environmental impact of fire and firefighting operations.
Content

4.1 THE MEANS OF FIRE PROTECTION AND PREVENTION OF FIRE AND SMOKE SPREAD WITHIN BUILDINGS IN RELATION TO BUILDING CONSTRUCTION AND DESIGN

4.1.1 The role of the Building Regulations 2010

The UK has had building regulations since the 1960's. Designing for fire safety in construction can be a complex subject. Successive revisions to the Building Regulations over the past 30 years have tightened up rules and learned lessons from notable fires in public places, such as Summerland (1973), Bradford Football Club (1985), and Eastbourne Pier in 2014.

The regulations were last updated in 2010 but they are likely to be changed in 2018 due to the review by dame Judith Hackett after the Grenfell Tower disaster. The regulations cover the specifics of building work and the construction standards of different types of buildings including houses and workplaces. There are a series of approved documents, these take the regulations and provide technical guidance on how the legal standards can be met. Approved document B covers fire safety issues for the construction and renovation of buildings.

The Building Regulations set standards for the design and construction of buildings to ensure the health and safety for people in or around those buildings. They also include requirements to ensure that fuel and power is conserved and that facilities are provided for people, including those with disabilities, to access and move around inside buildings

Although small-scale buildings such as individual dwellings are relatively simple, interpreting the rules for larger developments such as stadiums, shopping centres, factories and hospitals can require a specialist approach. There are a range of issues that may need to be considered when planning the fire strategy of any building project.

4.1.2 Approved Document B

The Approved Documents give guidance on how to comply with the Building Regulations. Fire safety is covered by Approved Document B, which is split into two separate sections:

- Volume 1 – Dwelling houses
- Volume 2 – Buildings other than dwelling houses

The two volumes are broadly similar in coverage and appearance, differing only to draw the distinction between the different building types. Volume 1 includes individual dwellings, and sheltered housing (where each individual unit is self-contained). Volume 2 covers everything else, but is assisted by supplementary guidance for special or complex building types such as healthcare buildings. Volume 2 also covers houses in multiple occupation, flats and student accommodation. They both have five parts, covering:

- B1 Means of warning and escape – split into horizontal and vertical escape, i.e. moving across a floor of a building to a stairwell, and then vertical escape down that stair to a place of safety. Escape stairs need to lead directly to the outside without passing through another compartment. Every room needs to lead directly to a protected escape route, without passing through another room (in which case it is identified as an 'inner room').The exception to this is kitchens, laundry or utility rooms, dressing rooms or bathrooms, and cupboards (but not store rooms). Vertical circulation, where a building is likely to be used by persons in a wheelchair, must be provided with space on each landing of the protected escape stairwell, so that they can await assistance in safety. Elderly residential care homes have special provisions for phased evacuation known as 'progressive horizontal escape', whereby staff can move residents from one compartment to the next, without having to evacuate all residents simultaneously.

- B2 Internal fire spread (linings) – fire is propagated across flammable materials, and the risk (and rate) of the spread of flames across that material is restricted by this section of the Approved Document. Certain areas are required to achieve a higher performance than others, for example escape routes. Flames are spread largely via walls and ceilings, rather than floors, although furniture and fixtures can also play a part.

- B3 Internal fire spread (structure) – this introduces the concept of 'compartmentation' of the building into smaller areas office-resisting construction, in order to restrict the spread of a fire. Typically, each floor will be regarded as a compartment, and that floor may be further subdivided. The vertical circulation shaft (containing lifts and stairs) is in effect another compartment, albeit spanning the building vertically. Its purpose is defined as a 'protected route'. Another aspect of this section of the Approved Document is the prevention of cold smoke transfer. Small spaces such as the cavities in external walls also need to be enclosed at compartment boundaries (both horizontal and vertical) by fire-resisting material, to prevent the spread of fire from one storey to another.

- B4 External fire spread – not only should a building provide a reasonable degree of fire resistance internally, but it should also prevent an internal fire from spreading to another building. Boundary and external walls need to achieve a degree of fire resistance (insulation and integrity), depending on how close they are to neighbouring structures or property. This can be a particular issue for glass, and also where an external escape route passes immediately adjacent to a window, for example.

- B5 Access and facilities for the fire service (Covered later in this element).

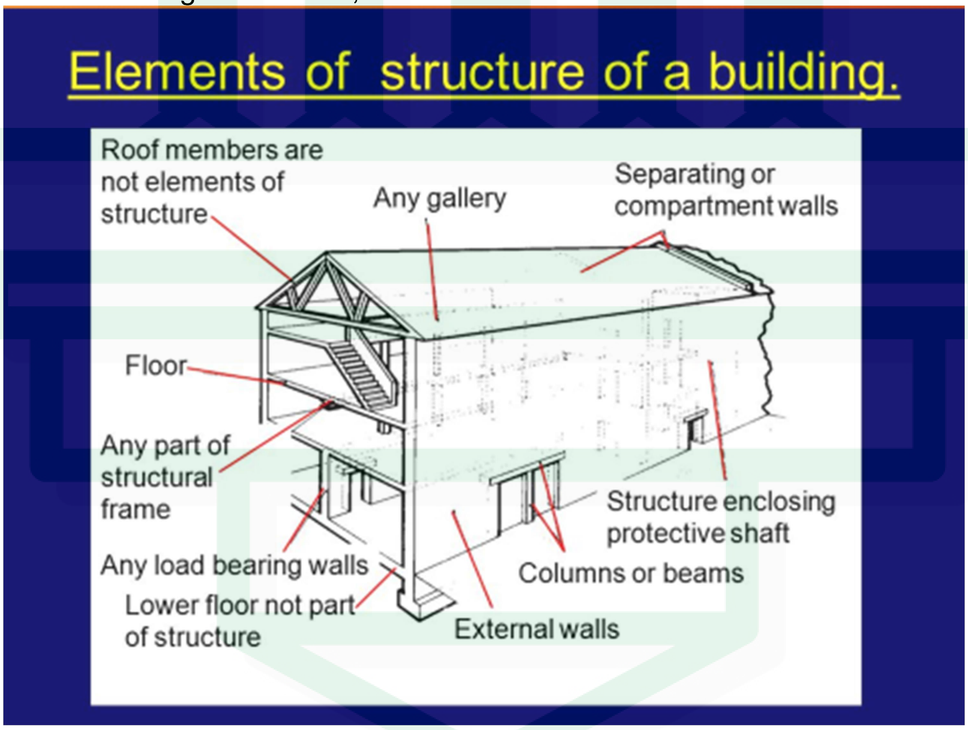
The most recent edition of approved document B was published in January 2013 and came into effect in April 2013.

4.1.3 Elements of structure - Building Regulations 'Approved Document B'

The main elements of the structure considered in the document are:

- Any part of a structural frame including beams
- Load bearing walls and elements
- Any floor or elements which support floors
- Stairs
- Ceilings and Walls

The fire resistance of a building will depend on the structure as detailed above, the work activities being undertaken, its size and contents.



4.1.4 Properties and requirements for fire resistance for elements of structure

The type and age of construction are crucial factors to consider when assessing the adequacy of the existing escape routes. To ensure the safety of people it may be necessary to protect escape routes from the effects of a fire. In older premises it is possible that the type of construction and materials used may be combustible. Issues which may affect the fire resistance of a structure include:-

• Cavities and voids being created, allowing the potential for a fire to spread unseen;

• Doors and hardware worn by age and movement being less likely to limit the spread of smoke;

• Damaged or insufficient cavity barriers in modular construction;

• Breaches in fire compartment walls, floors and ceilings created by the installation of new services, e.g. computer cabling.

Where an escape route needs to be separated from the rest of the premises by fire-resisting construction, e.g. a dead-end corridor or protected stairway then you should ensure the following:

• Doors, (including access hatches to cupboards, ducts and vertical shafts linking floors), walls, floors and ceilings protecting escape routes should be capable of resisting the passage of smoke and fire for long enough so that people can escape from the building.

• Where suspended or false ceilings are provided, the fire resistance should extend up to the floor slab level above. For means of escape purposes a 30 minute fire-resisting rating is usually enough.

• Cavity barriers, fire stopping, and dampers in ducts are appropriately installed

The materials from which a premises are constructed may determine the speed with which a fire may spread, affecting the escape routes that people will use. A fire starting in a building constructed mainly from readily combustible material will spread faster than one where modern fire-resisting construction materials have been used. Where non-combustible materials are used and the internal partitions are made from fire-resisting materials, the fire will be contained for a longer period, allowing more time for the occupants to escape. Because of the requirements of the Building Regulations there will probably already have some walls and floors that are fire-resisting and limitations on the surface finishes to certain walls and ceilings.

The employer will need to consider whether the standard of fire resistance and surface finishing in the escape routes is satisfactory, has been affected by wear and tear or alterations and whether any improvements are necessary. Fire-resisting construction can provide up to 30 minutes protection to escape routes but the fire resistance of a wall or floor is dependent on the quality of construction and materials used.

The fire resistance of floors will depend on the existing floor construction as well as the type of ceiling finish beneath. If there is a need to upgrade the fire resistance of a floor, if for instance higher numbers of staff are to be present, floor it may not be desirable to apply additional fire resistance to the underside of an existing ornate ceiling. In older buildings there may be a requirement to provide fire resistance between beams and joists.

The most common type of fire-resisting glazing is 6mm Georgian wired glazing, which is easily identifiable. Clear fire-resisting glazing is available and can quickly be identified by a mark etched into the glass, usually in the corner of the glazed panel, to confirm its fire-resisting standard. Although this is not compulsory, the marking of glass is supported by the Glass and Glazing Federation; The glazing should have been installed in accordance with the manufacturer's instructions and to the appropriate standard to ensure that its fire-resisting properties are maintained.

The performance of glazed systems in terms of fire resistance and external fire exposure should, wherever possible, be confirmed by test evidence. Although glazing provides additional safety in everyday use and can enhance the appearance of fire-resisting doors, it should never reduce the fire resistance of the door. The opening provided in the door for the fire-resisting glazing unit(s) and the fitting of the beading are critical, and should only be entrusted to a competent person. In nearly all cases the door and glazing should be purchased from a reputable supplier who can provide documentary evidence that the door continues to achieve the required rating.

4.1.5 Compartmentation

Compartmentalisation is one of the best ways of minimising the spread of fire. It gives people time to evacuate and may also reduce the extent of damage from the fire. Dividing a work area up into smaller sections will prevent or reduce the amount of fire spread. Compartments need to be separated from those next door by doors or floors to limit the growth and spread of fire. It can limit the fire damage allowing potentially the business to carry on operating if only part of the building or site is damaged.

Compartmentalisation is based on enclosures which are made of fire resisting materials which reduce convection, conduction and radiation. Any walls are designed so if they get hot they do not pass the heat through the face of the material. It is important that temperatures in fire evacuation routes are kept cool to prevent and delay the structure reaching a temperature which could cause it to fail.

Compartmentalisation is a passive fire protection method involving walls, floors, doors and ceilings. To ensure compartments are maintained is very important to ensure any openings, damage or gaps are not allowed to reduce the effect of any compartmentalisation. The various sections may be able to provide a temporary place of safety where people can wait until the fire authority can rescue them.

Travel distances can be applied within the different compartments, with each area containing its own hazards. Some areas will have a higher rating if they cannot be easily evacuated such as a control centre for a power plant or chemical centre.

For buildings which have more than one floor each floor is in essence a different compartment. This should be capable of containing the fire for a certain period without spreading to other floors. This type of protection offers safety to those who has to pass through a floor to escape and should also provide protection for the fire service who are on a floor above or below the seat of the fire.

For a compartment to be effective walls and structure needs to be built to a higher standard which is resistant to fire. This needs to include the structure of the building, as there is no point the fire compartment being fully safe if the rest of the building collapses around it. The term compartmentation is also used to protect fires spreading to adjacent buildings, it can restrict horizontal and vertical fire spread.

As a general guide the following elements of structure must offer a designated period of fire resistance:

- A wall that is common to two or more buildings
- Walls enclosing refuse storage chambers
- Kitchens
- Staircases
- Dead End Corridors
- Escape routes from basements.
- Plant rooms
- Hazardous areas

- Floors in any building with a storey over 30m above ground level

4.1.6 Fire stopping

Cavity barriers should be in place in floors and walls where hot air or fire could access and then spread rapidly through the building unchecked. Access to these areas is limited and difficult but having the barriers is a hidden built in means of protection. Barriers should be in place where external and internal walls meet, ceilings over long corridors and on the underside of any false floors or ceilings. When building alterations are completed it is important that the cavity barriers are not removed or damaged.

Cavity barrier inside the brick work

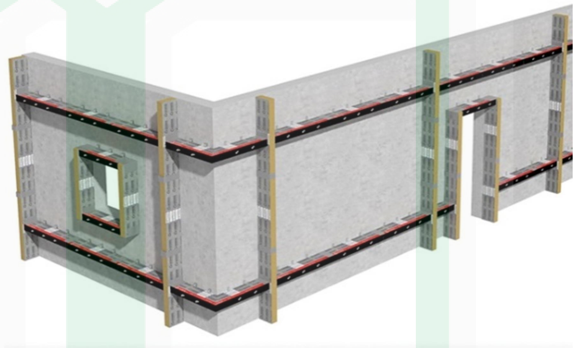


Figure: Cavity Barriers behind plasterboard walls

4.1.7 Penetration seals

This is when pipelines or cables are fitted and go through a structure, they need to be sealed to ensure there are no gaps which allow heat or gases to penetrate. There are a variety of different means of achieving this, it can be via a filling compound, silicone sealants, intumescent acrylic sealant, or fire collars which fit around pipework to protect where it enters a wall or ceiling. The exact type chosen depends on a variety of factors.

Figure: Poor fire stopping without penetration seals

- The length of fire protection needed, this could be 30 minutes or up to four hours
- Risk of vibration damaging the seals and allowing air through
- The penetration seal may need to expand when it heats up to ensure the seal is maintained
- If items are moving inside the seal the mechanical movement must not damage or erode the seal.

Penetration seals can be used to protect individual cables or pipes, the seal may be made of plastic, steel, cast iron or other non-ferrous metals.

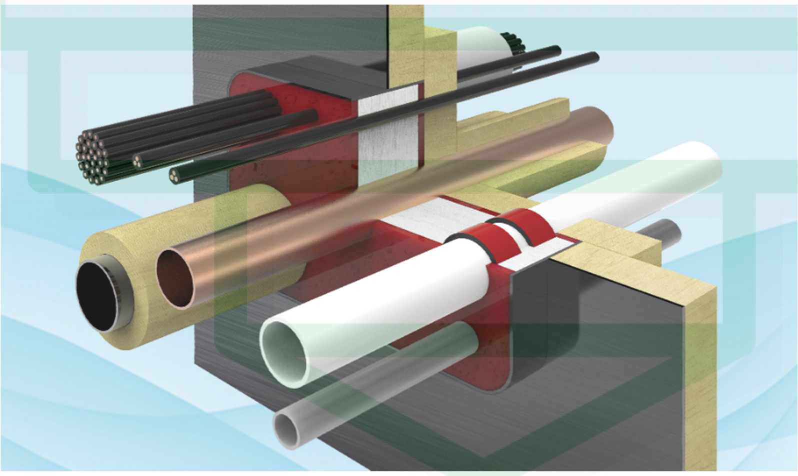
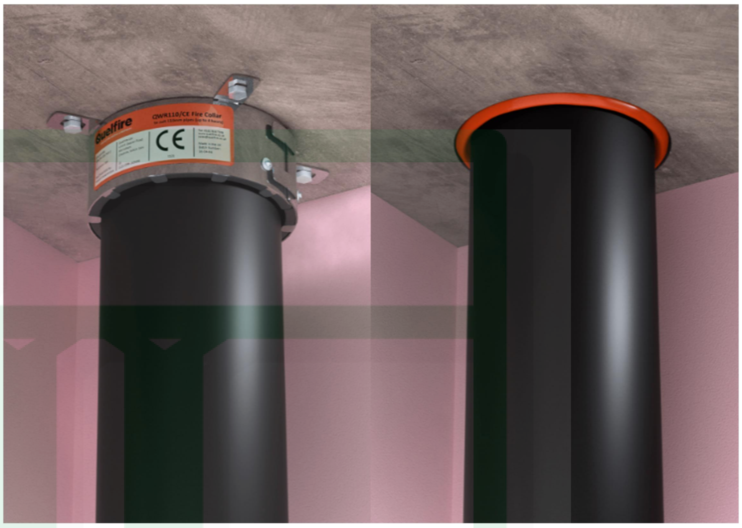
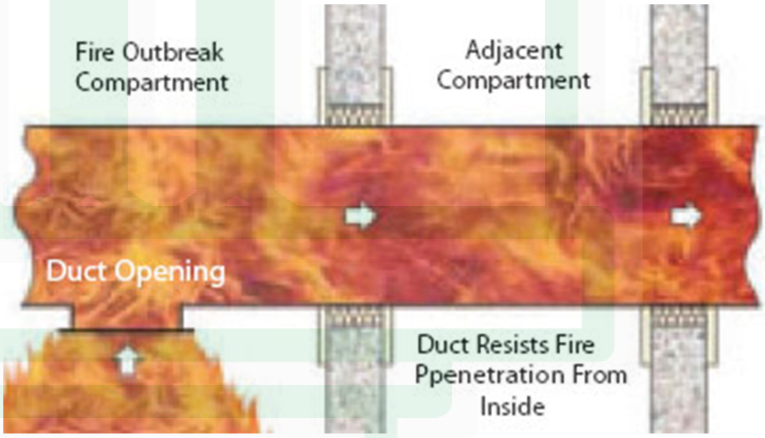


Figure Fire stopping around penetrating seals



Figures Fire resisting duct work



Fires can spread through ventilation ducts as these often pass through different rooms and even different floors. The ducting where fitted needs to be fire stopped where it goes through walls, ceilings or floors. The material the ducting is made of needs to be fire resisting with damper fitted inside which will block the ducting if and when a fire occurs.

4.1.8 Fire-resisting dampers (mechanical or intumescent)

Dampers restrict the flow of heat or smoke through the duct, they can be manual, mechanical or intumescent where they activate when a certain amount of heat is detected. The mechanical ones have a thermal sensor which activates them if a certain temperature is detected.

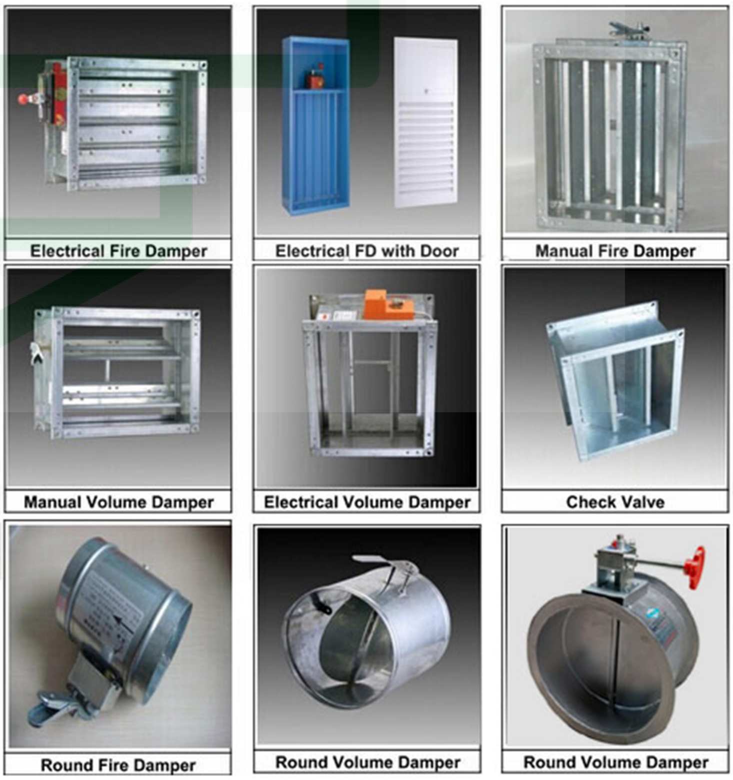
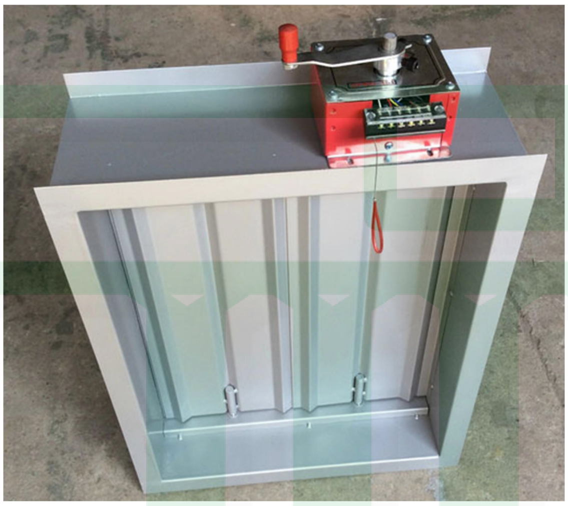


Figure showing a mechanical damper closed and open



4.1.9 Internal fire growth

It is not just the materials used to build a building which can affect the outcome of a fire. The internal linings of the structure can also influence its ability to resist fire. These are Building Regulations 2010 cover a variety of tests which need to be carried out on lining materials which consider the speed of fire spread and how they can contribute to a flash over in a room. In addition there is a British Standard (BS476) which classifies wall linings. The size of any fire compartments, the wall and ceiling linings, contents and building structure will all have an impact on the severity of any fire which occurs.

There are rating systems for different types of linings, some will increase the severity of the fire if they catch alight. Unsuitable linings and coatings on walls, especially on a means of escape could prove fatal. If the covering is flammable it may encourage the spread of fire along walls and ceilings which may heat other areas. The material may burn generating toxic fumes and gases which may travel under doors or through gaps into adjacent areas. Materials may melt and drop on to those in the area or onto other materials setting them on fire. Some coverings may generate lots more smoke than others.

Internal Lining Classifications

Class 0

These may be used anywhere in the workplace and places of circulation. They in brickwork, block work, concrete, plasterboard, ceramic tiles, plaster finishes and paper coverings on inorganic surface (other than heavy flock wallpapers).

Class 1

These should not be used on escape routes including stairways, corridors, entrance halls and lobbies but can be used elsewhere. Timber, hardboard, block board, particleboard (chipboard), heavy flock wallpapers, and thermosetting plastics.

Class 3

These should only be used in small rooms (floor area not exceeding 30m²) and parts of large rooms (does not exceed half of the total floor area up to a maximum of 60m²). Timber, hardboard, block board, particleboard (chipboard), heavy flock wallpapers, thermosetting plastics and thermoplastics (expanded polystyrene wall and ceiling linings).

The ability of the wall lining to burn will be increased significantly if they are painted over, especially with gloss paints.

Furniture with untreated foam can give off very nasty toxic fumes when it burns. The heat from a fire in furniture containing the foam reaches such a level that people cannot pass through it within about three minutes of the fire starting.

4.1.10 Fire-resistance

Any materials used in construction of a building will have an effect on the rate of fire spread. In new buildings the rate of fire spread should be slower than in an old building which may have been built with materials which are better at burning, with more combustible's being used. The condition of the building and any repairs or renovations which have been undertaken may interfere with the built in protection. Doors may have been removed or have had air vents fitted, there may be missing ceiling tiles or gaps around pipelines. The movement of smoke or heat can travel around any gaps potentially into hidden areas of the building.

Materials have a certain resistance to fire, this is the ability of a material in a building for a certain, stated, period of time. This is normally 30 – 60 minutes.

As mentioned previously the linings of walls and ceilings can increase the risk of fire spread even in a building built of low combustibles.

4.1.11 Alarm systems linked to forced ventilation system

Fire alarms can sound an alarm to enable building users to evacuate however automatic systems as well as sounding the alarm can trigger arrange of other automatic actions. A range of protective devices can be automatically actioned by an alarm. This may include:

- Automatic door closers
- Shutting down ventilation systems
- Closing down air ventilation systems
- Opening fire vents or starting fans to control and direct fire and smoke
- Allowing doors with swipe card or security access to open
- Trigger an alarm to the emergency services.

4.1.12 Means of preventing external fire spread

Construction of external walls and roofs

The materials used in the construction, any cladding on the outside could assist in the fire spreading to outside the structure. Once it is outside the fire could spread to other adjacent buildings for direct flame contact or radiant heat. If the building has openings such as doors or windows, if these are open the fire can make its way outside the building. If glazing or doors fail the fire can travel outwards and upwards.

When a roof catches fire this may spread the fire very easily due to the availability of fuel and oxygen. As roof materials heat up they may break down and burning embers may be sent up into the air and fly off making contact with adjacent buildings.

Distance between buildings

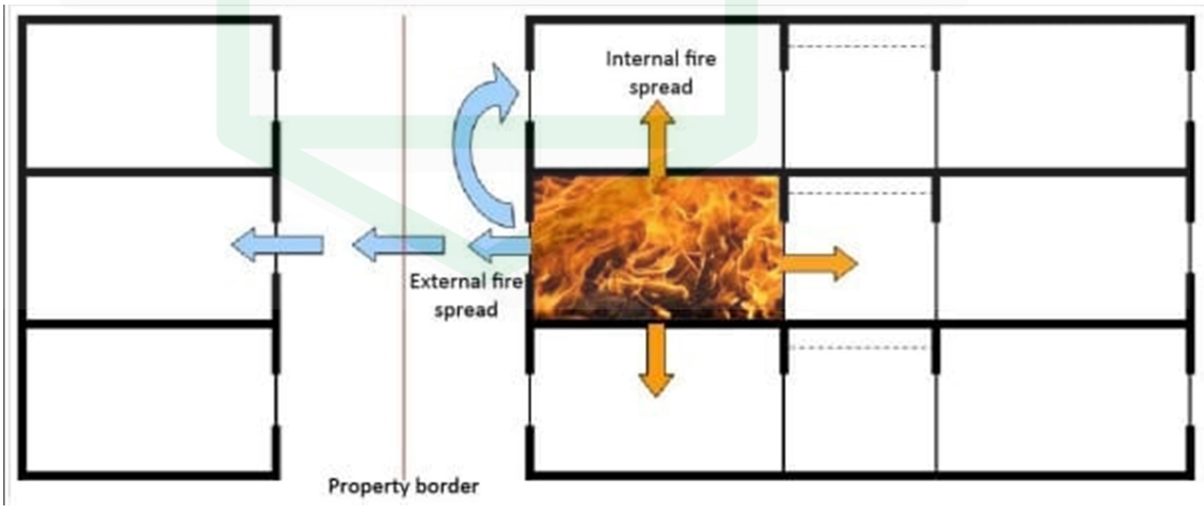
In the UK over history there have been a number of serious fires which have spread far and wide, building to building. A small fire in a bakery was enough to lead to the Great Fire of London in 1666. The buildings when attached allowed the fire to spread, those buildings which were separated were not saved as the fire spread via direct flame, burning ash and embers flying through the air on to adjacent structures or through radiated heat. Building materials such as metal on the outside of the building will heat up and could spread the fire to adjacent buildings. External building walls should give a minimum fire resistance of 1 hour.

Use/activities undertaken at premises

Activities which involve heat sources or naked flames outside or near external walls could I increase the risk to adjacent buildings. In some cases to reduce the risk hot processes may be completed outside which reduces the risk to the building but may actually increase the risk to adjacent buildings.

The role of the external walls in protecting escape routes at the boundaries.

When employees are leaving the building and making their way to the assembly point they may need to walk around the perimeter of the building on wither the inside or outside. This needs to be of suitable fire resistance, not covered with combustibles and not have lots of combustible material which may burn and fall off to injure those who are trying the leave the building. External walls will normally have a 1 hour resistance to fire.



4.2 MEANS OF ESCAPE

The means of escape includes rooms, corridors, and stairs and extends up to a point outside the building where assembly may take place in relative safety.

A safe means of escape is provided by structural elements forming an integral part of the building whereby persons can escape from fire using their own unaided efforts to reach a place of safety.

This means that the building must be designed and constructed to provide safe routes out of the building, wherever possible providing alternative routes in roughly opposite directions so that occupants can turn their backs on a fire and smoke to escape.

Routes should be unobstructed, doors unlocked, well signposted, provided with artificial light where necessary and free from combustible materials and ignition sources. Such routes should provide protected passage to a final exit door kept clear on the outside to allow rapid dispersal to safe assembly points.

Main issues to consider include:-

- The nature of the occupants, e.g. mobility
- The number of people attempting to escape
- The distance they may have to travel to reach a place of safety
- The size and extent of the 'place of safety'

The objectives of the means of escape are:

- To enable the evacuate of the premises in reasonable time (2-3 minutes)
- To ensure alternative routes available
- To ensure escape routes should lead directly to open air or a protected part of the building.
- To ensure no one should have to go towards a fire in order to get out of the building.
- To allow for unaided escape for able bodied

The basic principle of satisfactory means of escape is that persons should be able to walk unaided to a place of safety, regardless of where a fire might break out in the building.

- The distance persons should travel to reach a place of safety depends on the risk - the greater the risk, the shorter the acceptable distance of travel.
- Where direct escape to a final exit is not possible, a place of relative or comparative safety, such as a protected stairway, should be reached within a reasonable distance of travel.
- Unless a place of safety can be reached within a reasonable distance of travel, the escape routes will need to be protected from the effects of fire elsewhere in the building (e.g. by fire- resisting construction).
- Escape routes should always terminate in a place of safety.

- Escape routes should be wide enough to cater for the number of occupants likely to use them and should not reduce in width.
- There should be a sufficient number of available exits of adequate width from a room, storey or building.
- The required exits should be so spaced that persons can turn their backs on a fire and proceed in the opposite direction to a place of safety.
- Usually fire corridors will have a minimum of 30 minutes fire resistance to allow people to get to their place of total safety or final exit.

"Escape Route" – the route forming part of the means of escape from any point in the building to the final exit

"Final Exit" – exit from building where people can disperse where they are no longer at risk from fire or smoke

Mechanical ventilation via fans may be used to control smoke and keep it away from the means of escape but in large fire these may be overwhelmed. These systems may be used in conjunction with sprinklers. Natural vents may be used in high roofs and areas which panels which open and allow smoke out. Barriers may be put in place to direct smoke away from crucial areas such as the means of escape. There are also systems where stairwells can be pressurised to keep the smoke out.

4.2.1. Required safe aggress time (RSET) & Available safe egress time (ASET)

When smoke control and alarm systems are designed they take into account the Available Safe Egress Time (ASET), this is the amount of time that elapses between fire ignition and the development of untenable conditions preventing escape.

The Required Safe Egress Time (RSET) is the amount of time (also measured from fire ignition) that required for occupants to evacuate a building or space and reach the building exterior or a protected exit enclosure. RSET is the sum of the alarm time, the evacuation delay time (sometimes called the pre-movement time), and the movement time. Alarm time is the time at which occupants first become aware of a fire through a building's automatic or manual fire alarm system (occupant notification).

Both ASET and RSET are used in fire modelling calculations to work out if fire controls provide adequate protection. There are specific criteria for which include for the ASET:

1. Visibility must remain above 10 m.
2. Temperature must remain below 65° C.
3. Carbon monoxide concentration must remain below 1,400 ppm.

Finally, the movement time is the time required for occupants to reach a protected exit enclosure or the exterior of the building once the decision to evacuate has been made and occupants begin moving toward exits. The movement time is calculated by applying empirical relations for walking speed and occupant flow rates through egress elements such as doors, stairs, and corridors. Due to uncertainties associated with human behaviour, a factor of safety is generally applied to the movement time (and occasionally the alarm time, pre-movement time, and evacuation time) before the RSET is calculated.

4.2.2. Maximum Travel Distances

The exact distance of travel acceptable will depend on the building size, height and use. Recommendations are given in the Building Regulations approved document B.

Travel distance may be defined as the maximum distance to be travelled from any point in a building to the nearest:

- Final exit (that, an exit to a place of safety, normally the open air);
- Door to a protected staircase; this will apply on floors above and below ground
- Door to an external escape route (for example an alleyway, balcony, bridge, walkway, flat roof etc.)
- In effect, these definitions can often be combined; the travel distance, on any storey, is usually the maximum distance between any point on the storey and the nearest 'storey exit.

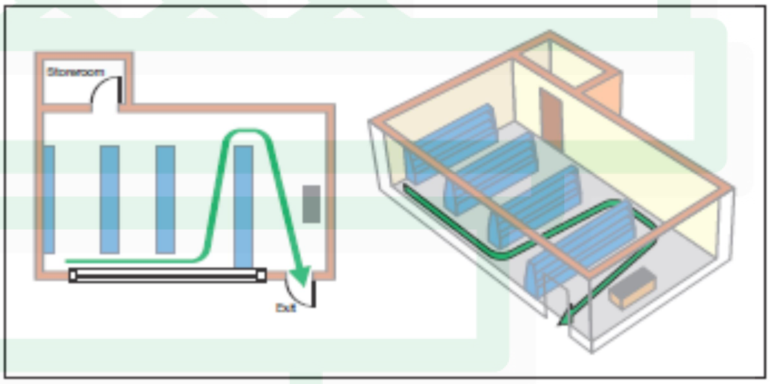


Table Recommended Maximum Travel Distances – Building Regulations

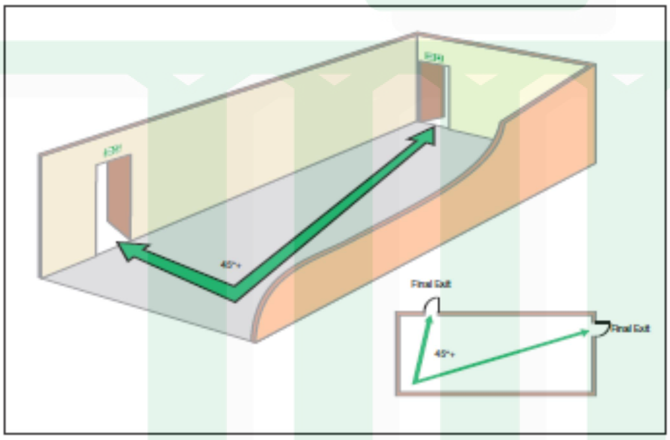
No of escape routes	Low Risk	Medium Risk	High Risk	Special Fire Risk
More than one	60m	45m	25m	18m
Single route	45m	25m	12m	9m

It is important that the escape route is wide enough so that it does not cause a bottle neck at any fire exit doors.

Escape Route Capacities Width at Least	
750mm (standard single door)	80 people (High risk)

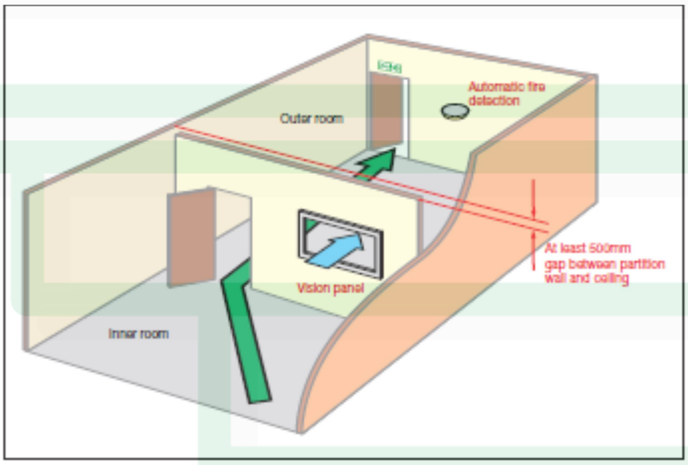
	100 people (Medium risk)
	120 people (Low risk)
1050mm (standard double door)	160 people (High risk)
	200 people (Medium risk)
	240 people (Low Risk)

Alternative Routes



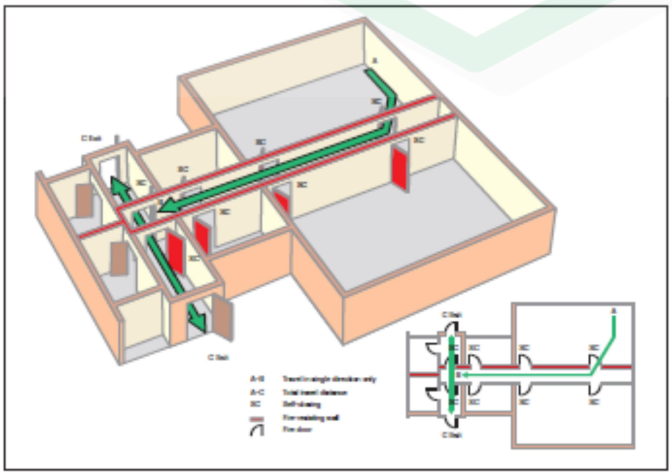
If there is more than one escape route the exits must be separate, i.e. not directly next to each other. To be classed as alternative the two exits must be at least 45 degree between each exit, as depicted in the diagram here. The only exception is if the two routes are protected by separate fire resisting walls or structures.

Room within a Room



Where the only exit is from one room to another there must be a vision panel so those in the inner room can see if there was a fire in the main room. No more than 60 people can be in the inner room or an automatic smoke detector should be in the outer room and an alarm sounder located in the inner room.

Dead Ends on Escape Route



There must not be anything on the escape route which will restrict the exit route and hinder escape. Usually automatic detection systems in areas where a fire could start should be fitted, the fire route must be a formally constructed escape route to there must be an alternative exit.

Staircase and fire routes

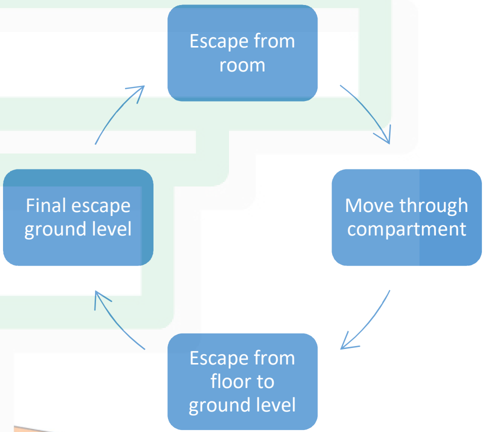
Stairwells usually form part of the means of escape, they need to be protected, protected from the rest of the building by a fire resisting structure. With a protected stairwell the travel distance is calculated to it rather than the final exit. Where there are 60 people on a floor then at least two protected exit routes should be provided. Doors leading on to a protected stairwell should be fire doors, they must be fitted with automatic closers in order to restrict smoke movement. Ideally the stairwell should lead to the final exit.

If there is a shared building with different companies having access to different areas then an automatic fire detection / alarm system should be in the building, with arrangements for co-operation and co-ordination.

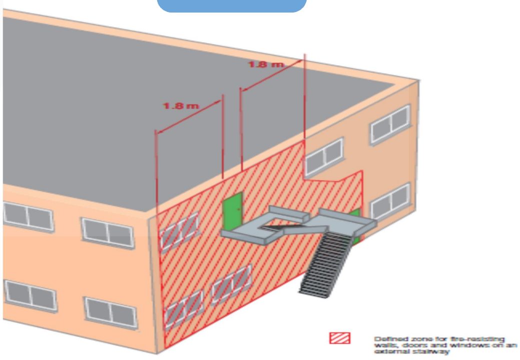
Limitation of travel distance alone does not ensure the adequacy of means of escape. In a crowded shop for example, a single, narrow exit door might be insufficient to enable all occupants to escape quickly enough to be safe from any fire that develops – even though no occupant were further than the maximum specified travel distance from the exit. The number and width of exits and staircases therefore, must be sufficient to enable sufficiently rapid evacuation.

Three stages of fire evacuation

- *Stage 1: travel within rooms*
- *Stage 2: horizontal travel to a storey exit or a final exit including:-*
  - Corridors with alternative means of escape
  - Dead end corridors
  - Open-plan areas
- *Stage 3: vertical travel down a staircase and thus to a final exit*



The term protected route means a route leading to an exit from a floor or to a final exit which is separated from the remainder of the building by walls, partitions, doors, floors and/or ceilings of fire resisting construction. The ability of a component or construction of a building to resist fire for a stated period of time, normally not less than thirty minutes.



A door providing means of escape must be kept unlocked and unfastened at all times when persons are in the building. Where security is important a panic latch or panic bolt should be used. Doors providing means of escape should open in the direction of escape especially from high risk areas or where access is provided to a corridor or stairway for more than ten persons.

In certain circumstance the Building Regulations allow self-closing doors to be fitted with an automatic device (electromechanical or electromagnetic) whereby the door remains open in normal circumstances but is automatically released and closes when the alarm is activated.

4.2.3 Fire Doors

Fire doors are provided to control smoke and to protect the means of escape. They are also used for compartmentalisation and the protection of special risk areas. It is essential that the fire door selected is suitable for its location and of sufficient size. The resistance of fire doors is determined using the test described in the British Standard BS476-22 or BS EN 1634-1.

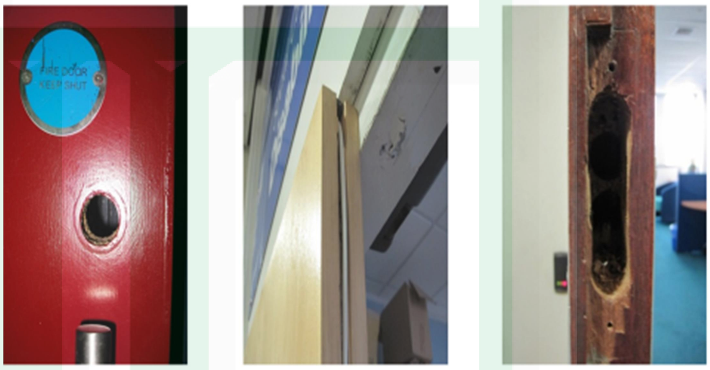


Figure: Fire Door Problems

All fire doors provided for the protection of escape routes should be fitted with smoke seals. In the early stages of a fire, smoke control should not depend on rebated door frames as doors are likely to warp, or heat activated seals which operate too late to protect an escape route. Fire doors provided for smoke control purposes should be capable of withstanding all smoke at ambient temperatures and a limited amount of smoke at medium temperatures.

Fire doors provided to protect the means of escape should be capable of resisting fire for 30 minutes, and withstanding all smoke at ambient temperatures and a limited amount of smoke at medium temperatures. (Labelling FD30 = will resist cracking for at least 30 minutes, with the suffix S means it will resist the passage of smoke.)

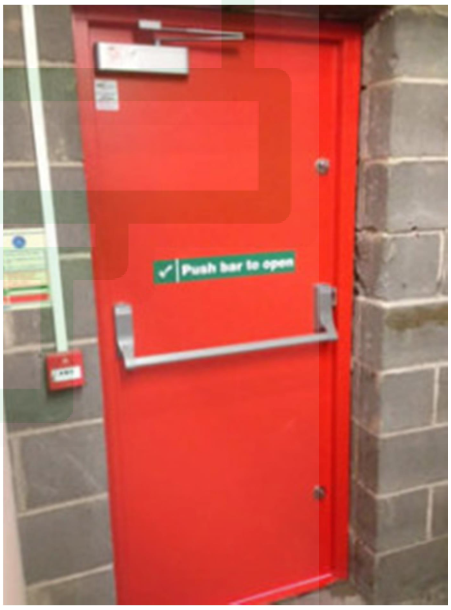


Image: Fire Door

Smoke stop doors are designed to restrict smoke movement, they need not be fire resisting. All must be self-closing, in a good fitting frame with a draught excluder fitted.

Depending on the material and method of construction different doors will withstand fire for different period of time.

- FD30 – 30 minutes (Half Hour)
- FD60 – 60 minutes (One Hour)
- FD90 – 90 minutes (Ninety Minutes)
- FD120 – 120 minutes (Hundred and Twenty Minutes)

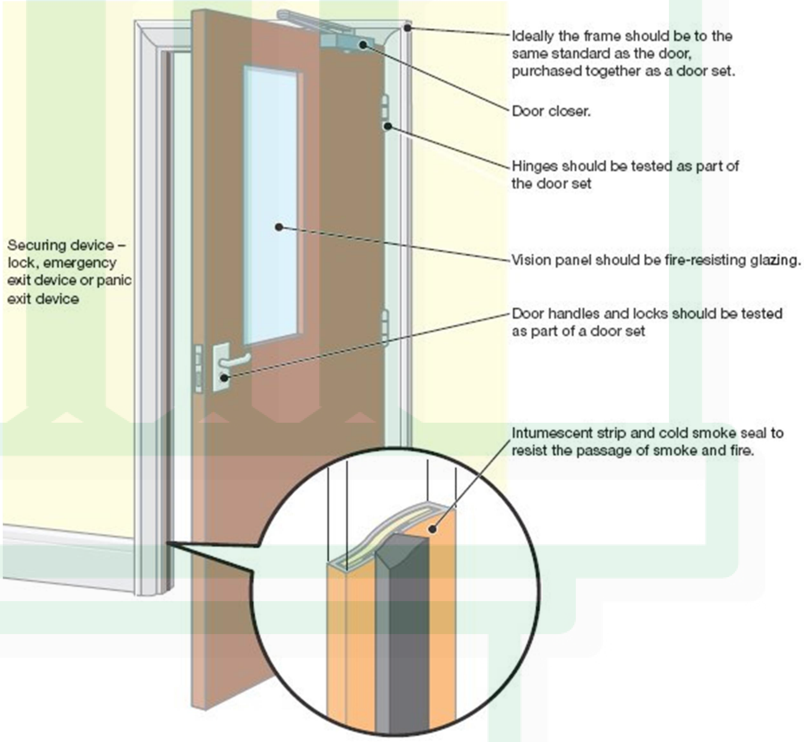
Protection of over 4 hours can be achieved using steel or iron construction however most fire doors are constructed of wood with a solid core of particle board, chipboard, flax board or a solid timber core and also fitted with an Intumescent strip.

Intumescent strips are used with wooden doors, the strip can be fitted into the door frame or the door itself. This swells with heat, expanding to fill the gaps and reduce the spread of fumes, smoke etc. They must be protected from vandalism and damage or else they will not work correctly when they are needed.

Internal fire doors should have closers fitted at the top of the door, these must be suitable for the size and strength of the door and allow the door to shut fully whatever the circumstances. The fire closer should shut around the fire or smoke seals.

In the main fire door closers are located at the top of the fire door but there are floor or lower spring versions which can be used, these normally have a slight delay before the door shuts.

Sliding and roller shutter doors are not generally recognised as fire escape doors but in some cases due to the nature of the building they may be used. For instance in the case of large green houses used in horticulture which traditionally due to the building structure type have sliding doors.



In double doors a door co-ordinater may be needed, these are used when the two doors need to close in a specific order to ensure they shut and form a seal.

All fire doors are there to assist the integrity of the means of escape so it important that they and their surrounding frames are maintained in good condition with no holes or damage which could allow heat and smoke through**.**

Figure: Double fire doors with door co-ordinator


Figure: Intumescent strip

Figure below: Fire Door Certification System Ratings

4.2.4 Emergency Escape Lighting

The purpose of emergency lighting is to illuminate escape routes, but it also illuminates safety equipment. The size and type of premises and the risk to the occupants will determine the complexity of the emergency escape lighting required. This may be "borrowed lighting", torches, and independent self-contained units with battery pack or fixed automatic emergency lighting.

Figure: Emergency lighting built into Signage

In simple single storey premises where borrowed lighting or torches are not appropriate, single 'stand-alone' escape lighting units may be sufficient and these can sometimes be combined with exit or directional signs as shown above. The level of general illumination should not be significantly reduced by the sign.

In larger, more complex premises a more comprehensive system of fixed automatic escape lighting is likely to be needed. This will be particularly true in premises with extensive basements or where there are significant numbers of staff or members of the public.

Figure: Wired emergency lighting – sometimes seen as a permanent green light

In warehouses and large open-plan areas in factories, an efficient and effective method of Illuminating escape routes in an emergency can be achieved by using spotlights such as the ones depicted below. These are normally self-contained units consisting of a battery, switching mechanism and spotlights fitted to operate automatically on a circuit or mains failure. These self-contained units can be suspended from roofs, structural steelwork such as columns or beams, substantial fixed high racking or attached to walls, etc. and are capable of illuminating escape routes easily.

Escape routes need to be adequately lit. If there are escape routes that are not permanently illuminated by normal lighting, such as external stairs, then a switch, clearly marked 'Escape lighting', or some other means of switching on the lighting should be provided at the entry to that area/stairs.

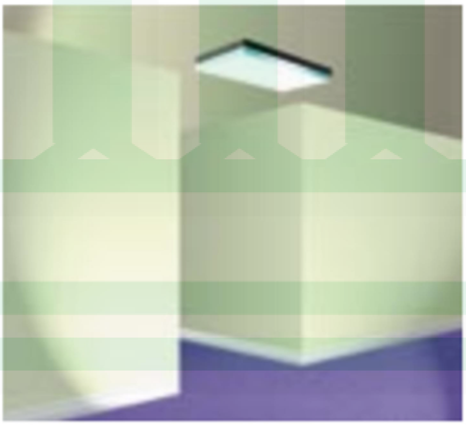
Figure: Emergency Spot Lights

As well as emergency lighting to allow escape there may also be systems for standby lighting to enable ordinary activities to be completed or protective safety lighting where an area has high risks and a lack of lighting would increase the risk significantly. The emergency escape lighting system should normally cover the following:

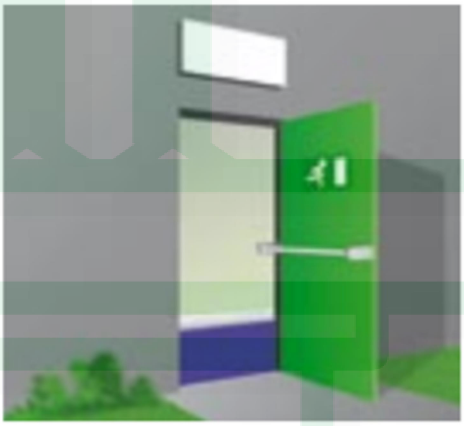
- Each exit door;
- escape routes;

• Intersections of corridors;
• Outside each final exit and on external escape routes;
• Emergency escape signs;
• Stairways so that each flight receives adequate light;
• Changes in floor level;
• Windowless rooms and toilet accommodation exceeding $8m^2$;
• Firefighting equipment;
• Fire alarm call points;
• Equipment that would need to be shut down in an emergency;
• lifts;
• Areas in premises greater than $60m^2$.

4.2.5 Points of Emphasis



At each corridor intersection



Outside each final exit

At each exit door

At fire fighting equipment

Emergency luminaries shall be located at points of emphasis, such as

- Changes in direction or level (trip hazards)
- Close to exit signs

- Close to firefighting equipment
- Outside final exits
- The bottom of staircases
- On changes of level
- At corridor intersections

Note. 'Close' means within 2 metres

It is not necessary to provide individual lights (luminaires) for each item above, but there should be a sufficient overall level of light to allow them to be visible and usable.

Emergency escape lighting can be both 'maintained', i.e. on all the time, or 'non-maintained' which only operates when the normal lighting fails. Systems or individual lighting units (luminaires) are designed to operate for durations of between one and three hours.

In practice, the three-hour design is the most popular and can help with maintaining limited continued use of your premises during a power failure (other than in an emergency situation).

Emergency escape lighting (luminaires) can be stand-alone dedicated units or incorporated into normal light fittings. There are highly decorative versions of these for those areas that demand aesthetically pleasing fixtures. Power supplies can be rechargeable batteries integral to each unit, a central battery bank or an automatic start generator.

To complement emergency escape lighting, people, especially those unfamiliar with the premises, can be helped to identify exit routes by the use of way-guidance equipment.

Any installation of emergency escape lighting should be carried out by a competent person in accordance with the appropriate standards. Further guidance is given in BS 5266-128 and BS 5266-8.27. All emergency escape lighting systems should be regularly tested and properly maintained to an appropriate standard. Most existing systems will need to be manually tested. However, some modern systems have self-testing facilities that reduce routine checks to a minimum.

4.2.6 Emergency Lighting Maintenance and Testing

Daily – check control panels & exit signs and luminaires are not damaged
Monthly – function test with key to check light is working, test emergency generators if fitted
Annually – Discharge test to ensure lighting stays on for a certain period of time usually 3 hours.

Any emergency lighting and power generators need to be maintained to ensure they work effectively, there is a delay when the generator is starting up, and it may not start up first time delaying the starting of the emergency lighting. If heat damages the generator it may not work. Arrangements need to be in place to maintain the generator and it may be difficult to isolate the power.

4.2.7 Design for progressive horizontal evacuation

This concept is generally used in hospitals and other large buildings where it is difficult to evacuate people out of the building. Progressive horizontal evacuation is the principle and process of moving patients and staff from the area of fire origin, which is compromised from a fire safety point of view, through a fire-resistant barrier, to a safe area on the same level. In the short-term, this will protect the occupancy from the effects of fire.

The area of safety is known as a refuge and will offer protection for a minimum of 30 minutes. In many cases of fire, this time is sufficient for the Fire Service to attend and the fire to be extinguished.

In cases where the 30 minutes may not suffice, onwards assisted evacuation by staff will be undertaken in order to move patients to a further adjoining area away from the fire or to a lower floor of the building. If each refuge move offers a further 30 minutes of protection, this provides adequate time for non-ambulant and partially-ambulant patients to be evacuated vertically to a place of safety, if necessary.

The time available for evacuation can be maximised with the use of active fire protection systems. Automatic-fire detection systems, smoke and fire detectors and/or fire suppression systems such as sprinklers may be incorporated into the building’s fire protection provision in order to provide prompt notification if a fire is detected and to slow the growth of the fire.

Areas which are accessible by patients should be designed to allow for progressive horizontal evacuation, unless those areas are for use only by patients who would be included in the independent category.

All movement in a progressive horizontal evacuation should be away from the fire and down towards ground level and the final exit from the premises. Patient-access areas must not, therefore, be located where evacuation would require travel up a stairway to a final exit.

4.2.8 Final exit to a place of safety

A place of safety may be outdoors, protected lobby, protected corridor or staircase. The distance people have to travel depends on:

- The degree of fire risk
- Their mobility
- Familiarity
- Speed of exit.

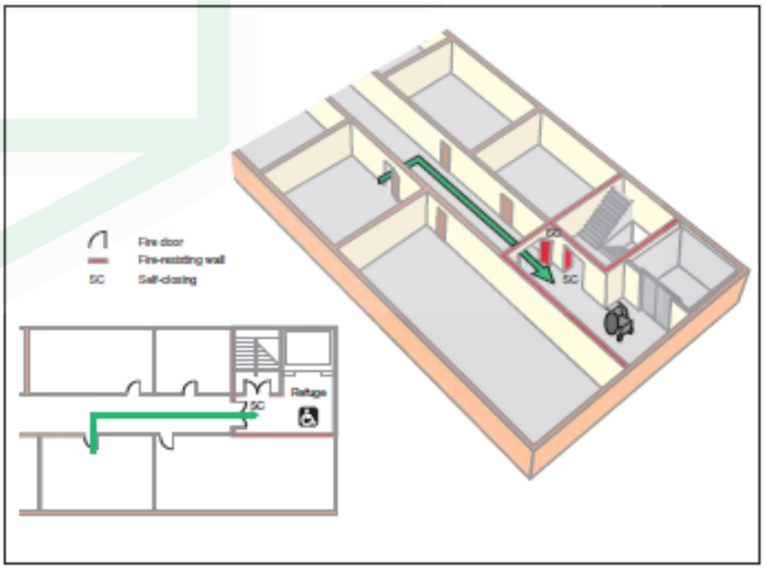


Figure: Typical refuge

Ultimately, all escape routes lead to a final exit from the premises.

Common requirements for final exits are as follows:

- The exits should be obvious and/or signposted.
- The exits must open easily.

Revolving doors are normally required to have conventional exit doors sited adjacent to them.

- In modern codes, wicket doors, goods delivery shutters and so on, are not normally acceptable as final exits, except in some codes in very restricted circumstances, where a very small number of persons are involved (for instance no more than 10). These exits are virtually always regarded as unsuitable for members of the public under any circumstances.
- On escape through a final exit, it must be possible to disperse from the building.

4.2.9 Management actions to maintain means of escape

Employers and occupiers need to ensure that the “means of escape” is maintained at all times. This may be done by regular inspections to ensure escape routes are clear and not obstructed, floors are in good order, and emergency signage is clearly visible. Doors on the route must be unlocked or easy to open and emergency lighting may be needed if natural light is not sufficient to allow the person to move around and see the exit route. Arrangements will need to be made for any vulnerable people – these will be considered in Element 5.

4.3 GIVING EARLY WARNING IN CASE OF FIRE - FIRE ALARM AND FIRE DETECTION SYSTEMS

In any building (or part of building) there should be a means for giving warning of fire to persons in the building. A fire warning system should consist of detectors and manual call points (break glass units) strategically situated throughout a building, which are connected to a control indicator panel. Depending on the type of fire warning system installed information will be displayed on the control panel (see image) indicating which part (zone) of the building the alarm signal originated in.

In the event of a fire, the control panel will identify which zone, detector or manual call point has been actuated and therefore the location of the fire. It will also actuate the fire alarms for evacuation, etc. Some fire warning systems may also be connected to automatic fixed extinguisher systems and have a direct communication route to the local fire brigade.

In addition, the fire warning system may also include the connection of relay contacts which may be regarded as the interface between the warning system and the main building services, such as lifts, air conditioning systems, dampers, isolators etc. Operation of the warning system will prevent these services from working, or will change their mode of operation e.g. lifts will automatically go to ground level and stay there. Air conditioning systems will be switched off and dampers will close down all open ducts or orifices in order to prevent the spread of fire or smoke throughout the building.

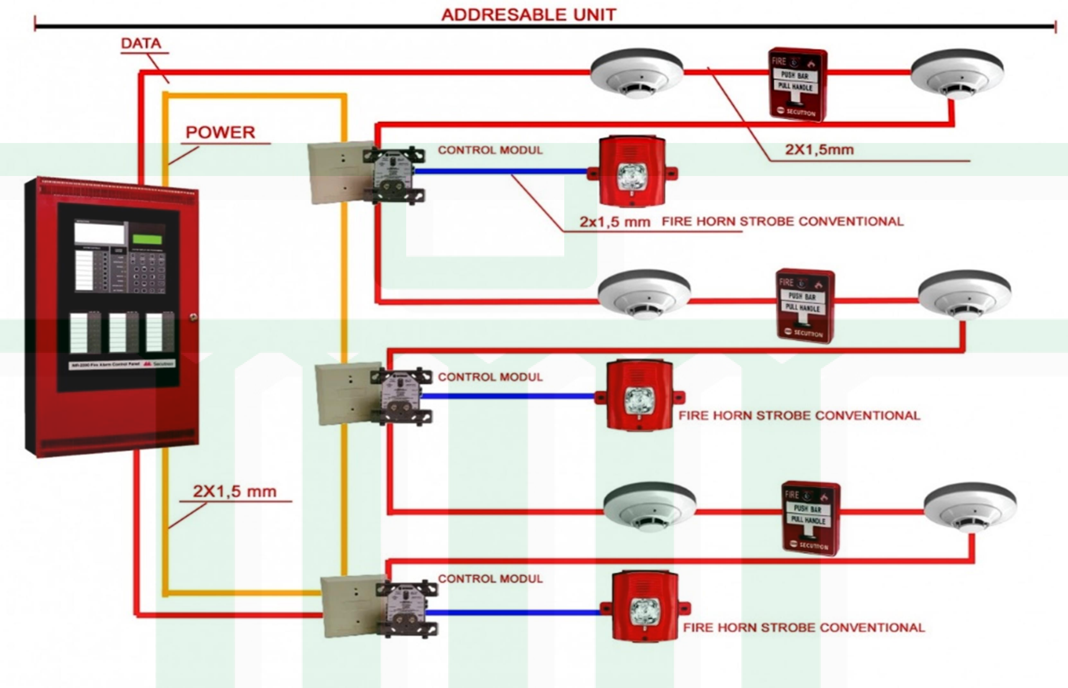


Figure - Example schematic of a fire alarm and detection system

4.3.1 System Types

The British Standard on fire alarms (BS 5839, Part 1 and Part 6) are an essential resource for those who design and install fire detection systems in commercial properties, as well as for local authorities, housing associations and the fire brigade. They outline the types of fire detection and alarm systems that should be installed in commercial buildings to give protection against fire.

These standards act as a guide to ensure fire alarm systems fulfil two key objectives – saving lives and protecting property. Due to the huge variety of applications for fire detection systems, the British Standards divides them into several different categories. Here's a run through of the categories, the levels of system and what they mean.

Category M Fire Detection Systems
Alarms under this category are manual fire alarm systems where the alarm must be activated, for example by a person using a fire call point. These systems tend to be fairly basic and require a human to discover the fire and take action.

Category L Fire Detection Systems
Category L systems are automatic fire detection and alarm systems with the aim of protecting life. There are 5 levels within this category, each offering a different level of fire protection.

L1 – Earliest possible fire detection
Fire alarms should be installed throughout a building to provide the earliest possible warning. This is critical in commercial premises where there are many people present on site.
L2 – Fire detectors for defined areas
This level of protection requires alarms to be installed in defined parts of a building to give occupants as much time as possible to be evacuated, before escape routes become impassable due to smoke and flames.

L3 – Protecting paths to fire escape
Similarly to level 2, this level involves installing detectors in defined areas, the difference being with level 3 that fire detectors should be placed in rooms that open onto an escape route.
L4 – Protection of fire escape routes
Fire detectors should be placed along escape routes and in other circulation areas, such as corridors and stairways. The objective of this is to protect escape routes so that people can exit a building safely during the event of a fire.
L5 – Localised fire protection
In some buildings fire detection systems may be needed to satisfy a specific fire safety requirement. For example there may be an area where a fire would pose a high risk to the lives of occupants. Under these circumstances, detectors would be required in these locations whether this includes just one room or even entire section of a building.

Category P Fire Detection Systems

Category P systems have the primary aim of protecting property from fire. There are 2 levels, which offer a different level of protection depending on the fire threat.

P1 – Complete fire protection for earliest possible warning
These detection systems offer the earliest possible fire warning. Detectors and alarms should be placed in all areas of a building, so that the moment a fire breaks out the fire brigade can be alerted to stop the spread of the fire and minimize damage to property.

P2 – Fire detectors for defined parts of a building
Where the threat to property and therefore business is high in particular areas of a building, more specific coverage may be needed. Areas with high fire risk, particularly where there are several fire hazards present will require special warning. This could refer to a single room but it can also be extended to cover the entire floor of a building.

Selecting the most suitable system

Unfortunately, there is no one size fits all solution. In order to find the most appropriate category and type of detection system for your premises – you need to look at your specific fire safety objectives. It is important to consider that are the primary fire safety objectives – protection of people or property? This will depend on the business, the people present on site and numerous other factors which are explored in this and the other five elements of this qualification.

4.3.2 Sounding the Alarm

a. Warning Signals

The signals and warnings from a fire alarm system can be in a variety of forms including bells, sirens (see image), hooters (see image below) or public address system. Any system incorporated into the electrical alarm system should be distinctive especially in premises where the noise levels may be excessive. Additionally in any other situation where a normal type of sounder may be ineffective e.g. where those with hearing problems are present, visual signals should be used to supplement the audible alarms. Tests have proven that a flashing white strobe is the most suitable for this purpose.

In situations where people are present, alarms must not be operated solely by the detector system but must also have manual operation points (BS 5839). There are a variety of ways in which alarms may be connected in order to meet the needs of different buildings.

Alarms may be sounded as follows:

Simple - all alarms sounded.
Zoned - alarms sounded in alarm zone and neighbouring zones. This may be a continuous alarm in the zone where the detection has been activated and an intermittent sound in the adjacent zone.

As a guide the minimum alarm sound level at any point in the premises should be 65dB(A) or 10dB(A) above the ambient noise levels. Where there are people who are sleeping, who are drugged or on medication, the sound level should be increased to 75dB(A) or more.

b. Zones

Detectors and call points are arranged in zones which may be considered as unit fire compartments, each with a floor area less than 200m^2. Each zone is connected via one individual loop of wiring to the control and indicator panel. More complicated buildings may utilise a zone/sector definition, where the main indicator board will display sector fire location information and sector boards will display zone fire location information.

The control and indicator panel, besides showing the location of a fire should also provide information on power supply faults, wiring faults and/or general faults. (British Standard 5839).

c. Audible Alarms by Intercommunication or Public Address Equipment

Where intercoms or a public address system are used instead of conventional sounders, the signal should take priority and override other facilities of the equipment. The alarm signal, which may be followed by a voice transmission of essential information for safe evacuation, should be distinct from other signals which may be in general use on the system. (British Standard 5839: Part 1 gives advice on general requirements.)

d. Emergency voice communication (EVC)

An emergency voice communication (EVC) system allows firefighters and others to communicate with one another during emergency situations. The system also allows communication with disabled persons or fire wardens in refuge areas.

EVC is a “System that allows voice communication in either direction between a central control point and a number of other points throughout a building or building complex, particularly in a fire emergency situation” (BS5839-9:2011 3.4).

EVC systems are needed in any building where there are disabled people or people who may have difficulty negotiating the evacuation route. They are also used in buildings with phased evacuation and sports style venues where it will assist stewards with control or evacuation of the site. It is sometimes referred to as:

- Disabled refuge system (DRS)
- Fire telephone system
- Emergency / steward telephone system

Evacuation of a building needs to be done swiftly and efficiently taking all occupants into account. For those occupants with disabilities or mobility impairments, safe and organised evacuation is paramount. Usually installed within a building or exit staircase, Disabled Refuge or Emergency Voice Communication Systems (EVC) are a method of allowing building management and emergency services to assist these people from the building.

Building Regulations insist all new non-domestic buildings with more than one story provide 'refuge' areas – relatively safe places where people who cannot easily use fire escapes and evacuation lifts can call for assistance and wait until help arrives. The Regulatory Reform (Fire Safety) Order also asks for provision to be made for escape or disabled people. Emergency Voice Communication Systems provide a two way voice communication between a refuge area and building control to assist rescue teams and reassure people that help is on the way.

e. False Alarms

In the event of a false alarm, it is important that the cause and extent of the problem is determined as quickly as possible. This is especially important where there is disruption to the fire warning system resulting in a substandard level of protection. It is essential that the utmost care should be taken by system designers, installers and users to reduce the incidence of false alarms. (See Element 1).

f. Manual Call Points

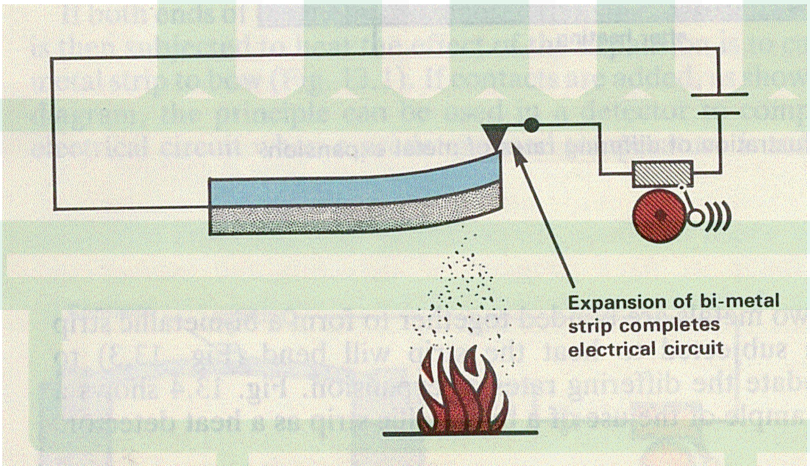
Premises where people work must always have manual call points fitted. Manual call points are the square "break glass" appliances commonly located around work and other premises. Generally, no point in a building should be further than 30m from a call point, although this distance should be reduced where there are specific fire hazards. Call points may be connected to the same wiring circuit as automatic detectors but the possibility of disabling the manual system during false alarms or servicing should be taken into account.

4.3.3 THE METHODS AND SYSTEMS AVAILABLE TO GIVE EARLY WARNING IN CASE OF FIRE - HEAT AND SMOKE DETECTORS

Smoke detectors are normally sited at the highest point of a compartment. In addition to the actual detector/alarm components it is also very important to have a fully independent and integral electrical wiring system. The wiring will connect all the components in a complete fire warning system and ensure the correct sequence of events is followed in the event of a fire. Fire detectors detect one of the three characteristics of fire: heat, smoke or flames. The advantages of one system over another will depend on the specific purposes for which the system was initially installed and the physical reactions of the contents, etc. in the event of a fire.

A. HEAT DETECTORS

Heat detectors sense if there is a significant rise in temperature at ceiling level. They are unable to detect earliest stages, they are slower to react than a smoke detector. These are suitable for unoccupied rooms or spaces, as they are less sensitive than smoke detectors that suits kitchens and areas with dirty and dust laden atmospheres. They tend to be robust and more tolerant of extreme conditions than smoke detectors.



There are three main types of heat detectors, fixed temperature, rate of rise and linear.

"Fixed temperature" (FT) heat detectors respond when the heat level reaches a fixed pre-set value. These utilise various reactive properties of certain materials when subjected to heat. They are used where high ambient temperatures exist or where sudden changes in temperature can occur e.g. kitchens, boiler rooms & foundries etc. A fixed temperature trigger point should be selected to ensure they do not go off just because of the normal heat generated.

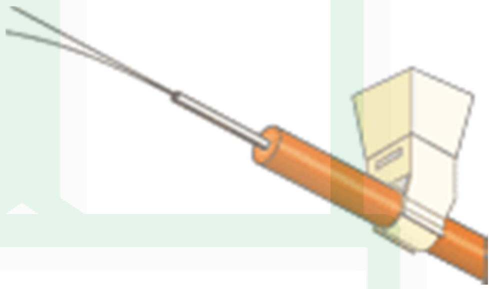
Alternatively **"rate of rise" (RR)** heat detectors respond to an abnormally rapid temperature rise although many also incorporate an upper fixed temperature setting. The detectors usually rely on lasers or infra-red heat. This type of detector is more sensitive than a simple fixed temperature heat detector and as such is the choice for applications in which reliable performance and early warning are critical but where the environment makes smoke detection impracticable.

Examples of suitable locations for Heat Detectors

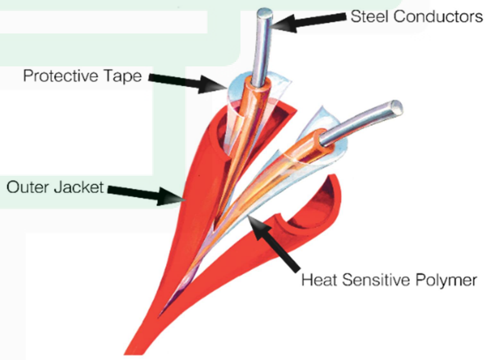
Before selecting the type of heat detector it is necessary to confirm the environment into which the installation is to be placed e.g. are there local heat generating facilities such as ovens, burners, process machinery? What is the maximum temperature achieved in the protected area?

Location	**Rate of Rise**	**Fixed Temp**	**Fixed High Temp**	**Reason**
Boiler Room		#	#	Rapid change in room temperature
Drying Room	#			
Kitchen			#	Avoid locations over ovens
Loading Bays	#			
Smoky Atmosphere	#			

Linear Heat Detectors



These are suitable for ducting and areas where access is difficult. They can also be used in flammable and explosive atmospheres as they are insulate. It is in the form of a coaxial cable constructed with a copper coated steel central conductor, an inner insulation (dielectric), a tinned copper braid layer and PVC overall protective sheath. The cable may be installed in explosive rated zones Areas where intrinsically safe equipment is required. The detector is particularly suited to applications where harsh environmental conditions preclude the use of other forms of detection. This type of detector is suitable for cable tunnels, ducts, escalators, conveyors and ceiling voids.



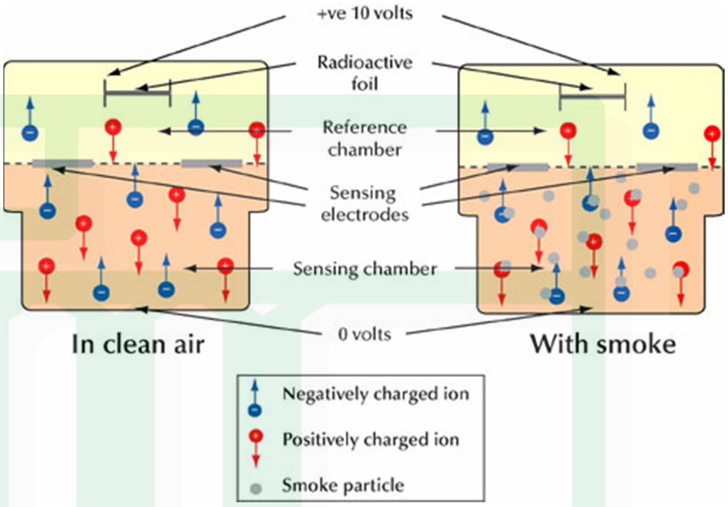
Heat detectors are suitable for most buildings and show a greater resistance to adverse environmental factors than smoke detector. They are good for detecting fires with rapid heat evolution but may not detect a fire with little or no smoke.

B.SMOKE DETECTORS

Smoke is a complex suspension of combustion gases and liquid and solid particles, which displays varying optical properties ranging from almost transparent to black opaque. The size of the smoke particles, determined by the materials being burnt will, to a certain extent, dictate the type of smoke detector used.

Ionisation smoke detectors

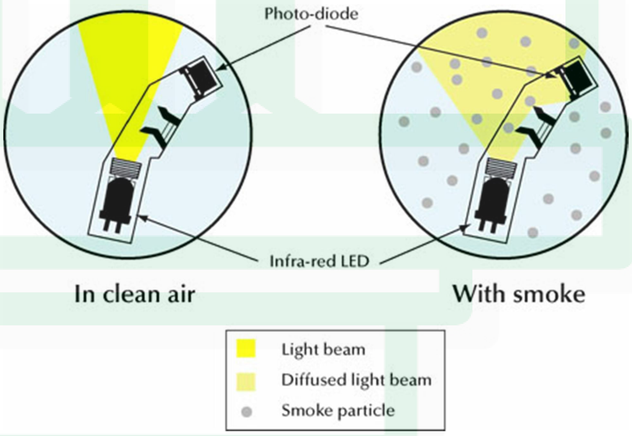
These work by detecting a change in electrical current within the detector as the smoke particles interfere with the system and charged ions they contain.



A radioactive source (usually an alpha emitter) is involved in the ion system. Generally ionisation smoke detectors will respond most quickly to smoke containing small particles e.g. from chip pan fires, as they will detect the fire before the smoke gets too thick but have a less rapid response to smouldering fires involving polymers (plastics) and slow burning fires from things such as foam.

Optical detectors

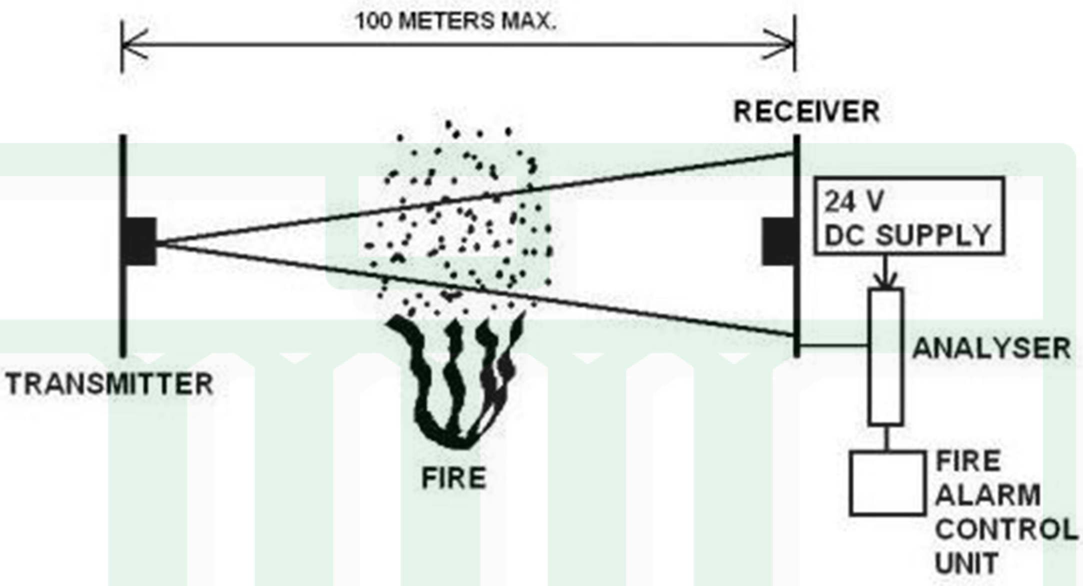
Optical point detectors detect an obscuration and/or scattering of a focused light beam by the smoke particles. Ambient light conditions must be considered for the placement and use of these detectors. Optical smoke detectors are usually point detectors although air and/or smoke may be specifically conveyed to a conventionally placed detector by way of an air sampling system. In contrast to ionisation smoke detectors, optical systems respond more effectively to dense, heavy particulate smoke.



Although smoke detectors generally provide acceptable protection in a majority of buildings, there are known problems with false alarms caused by tobacco smoke, dust etc., and certain chemical dyes e.g. involving alcohol, which will not activate smoke detection systems as smoke may not be evolved in the combustion reaction. These detectors are useful for larger particles of smoke from smouldering foam and PVC wiring as they will detect slow burning fires.

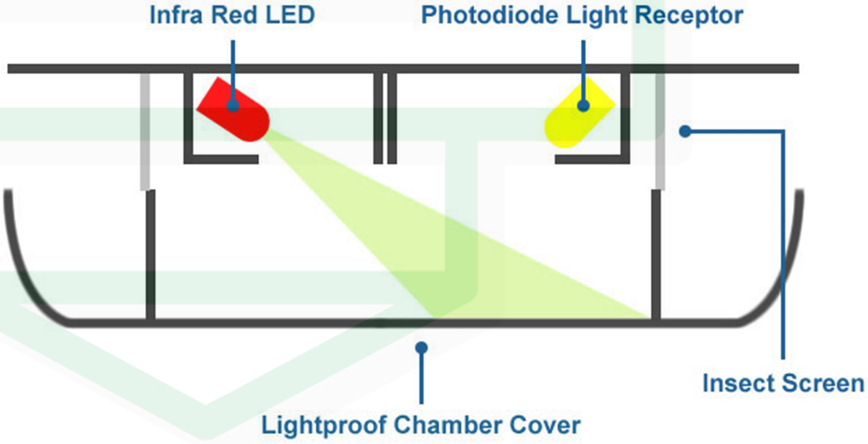
Laser detectors

A laser beam has been adapted as a fire detector on the same basis as an optical detector. The advantage of a laser is that the beam will travel over 1000 metres without divergence, so allowing a detector to cover very large areas. Problems can arise at the detector beam and optics due to movement of the whole building or sections supporting the optics.



C. FLAME DETECTORS

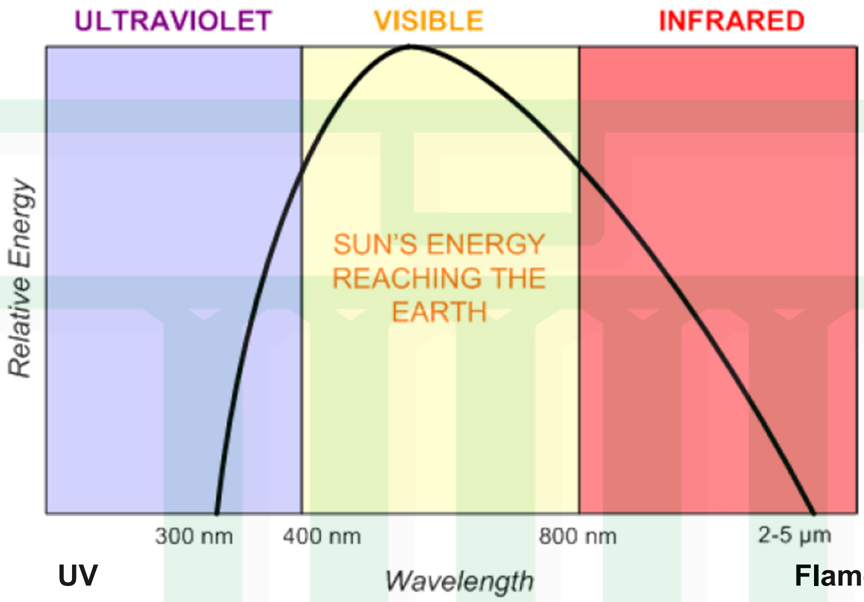
Flame detectors detect either infra-red (IR) or ultra-violet (UV) radiation emitted by the flames of a fire. Infra-red detector systems respond to the low flicker frequency associated with diffusion flames and, together with UV detectors, will not generally detect the flames of certain oxygen / gas mixtures. UV flame detectors respond to a limited ultraviolet band of 185-260 nanometers. This limited band excludes radiation from the sun reducing false alarms. IR detectors respond to a narrow band of infrared radiation, flames produced by



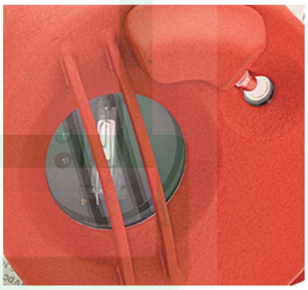
hydrocarbon fuels emit a large amount of IR radiation so they are very suitable where fuels are present.

Optical flame detectors respond to electromagnetic radiation in the ultraviolet, visible and infrared spectrums emitted from a burning flame.

The protection area may be static and defined, with mobile scanners to check a wider area.



UV Flame Detector



- UV flame detectors offer extremely fast response times, typically 100 milliseconds, allowing then to react at the very early stages of a fire.
- However UV detectors are potentially sensitive to arc-welding, x-rays, halogen lighting and lightning, therefore posing false alarm problems.
- A good application for UV detectors is in side turbine enclosures, where speed of response is critical and the sources of false alarm are not present.
- UV detectors cannot see through thick sooty smoke.

IR Detector

- IR flame detectors have the advantage of been able to detect through dense smoke and are less susceptible to contaminated optics.
- IR detectors are not sensitive to arc-welding, x-rays, halogen lights and lightning.
- Typical response time < 2 seconds.

D. DETECTOR SELECTION

All the detectors covered have a use but there is no single one which is ideal for every application, as some would be too slow and others would be unreliable. To choose the best type of detector the following points must be considered:

- The environment in which the detector must work: dust, fumes, corrosive vapours, etc. Sensitivity of the detector compared with the problem of false alarms.
- The location of the detector with its ability to pick up an indication of fire.
- The construction must be compatible with the area in which the detector must work e.g. robust detectors will be required for engineering works.
- The fuel sources and their ability to generate heat, flames and smoke

4.3.4 USE OF ALARM RECEIVING CENTRES (ARCS)

ARCs provide reassurance to employers and building owners that fire alarms are monitored 24 hours a day, 365 days a year. Activation signals are sent to a monitoring centre, where they are filtered for false activations whether from abuse, criminal acts or unintended activations.

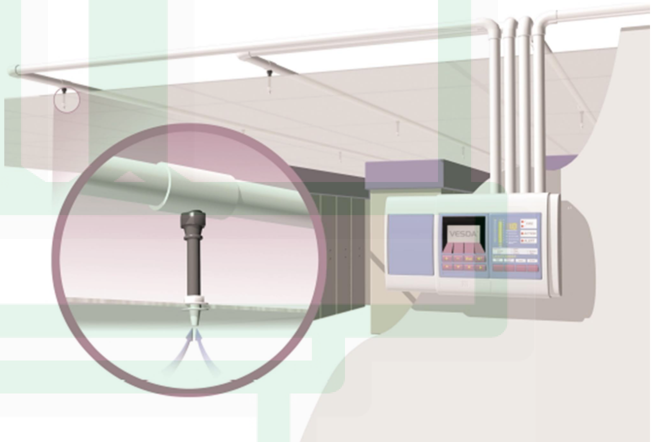
In the event of a confirmed signal the relevant emergency services are contacted, ARC's may also monitor via CCTV systems which can be useful to check in areas where the activation has been triggered. ARCs are rated on how quickly they respond to alarms.

If any automatic fire alarm system is monitored in this way it may reduce the number of false calls out for the emergency services.

4.3.5. SELECTION AND CERTIFICATION OF FIRE ALARMS AND CONTROL SYSTEMS

There are a range of factors to be considered in the selection of fire detection and fire alarm systems:

- Number of lives at risk
- Activities undertaken
- Behavioural issues
- Social behaviour and minimising false alarms
- Building type and function



Certification

The commissioning process involves the thorough testing of the installation to the recommendations of the appropriate British Standard – BS 5839 Part 1. The commissioning engineer should confirm that all is ok with the system and do the handover to ensure the employer knows how to use it and test the system. A commissioning certificate should also be provided, this states system meets the standard but it doesn't certify that the design was suitable in the first place.

Verification should be completed by a qualified competent independent third party e.g. BAFE accreditation.

4.3.6 FIRE SYSTEM CHECKS AND MAINTENANCE

In order to fulfil the requirement of a suitable system of maintenance, all facilities, equipment or devices must be in an efficient state and working order, in a good state of good repair.

This is achieved by regular checks and proper maintenance procedures. Regular inspection and testing by the responsible person and a competent person is necessary at suitable intervals. These checks ensure that any faults or failings will be found and rectified as quickly as possible.

The appropriate checks and procedures can be found in the relevant codes of practice such as BS 5306 for portable extinguishers and BS 5839 for fire detection and alarm systems.

The routine may vary with the use of the premises. For example, equipment installed in corrosive or dirty environmental conditions will need to be checked more thoroughly and at more frequent intervals than in clean and dry situations. In such instances, the recommendations of the supplier or installer should be followed.

Daily attention by the user

A check should be made every day to ascertain that:

- the panel indicates normal operation. If not, that any fault indicated is recorded and is receiving urgent attention

- any fault warning recorded the previous day has received attention

Weekly attention by the user

- At least one manual call point should be operated to test the ability of the fire alarm control panel to receive a signal and sound the alarm and to ensure that the fire alarm signal is received at any alarm receiving centre to which fire alarms signals may be transmitted. It is not necessary to confirm that all fire alarm sounder circuit's operate correctly at the time of the test. A different manual call point should be used at the time of every weekly test so that all manual call points in the premises are tested in rotation over a period of time.
- The duration of the sounding of the fire alarm signal should not exceed one minute at the time of the weekly test, so that, in the event of a fire at the time of the weekly test, occupants will be warned by the prolonged operation of the fire alarm sounders.
- Fire doors fitted with automatic releases and any other active fire measures triggered by the alarm system should be checked that they are operating efficiently.
- An entry should be made in the Log Book quoting the particular manual call point that has been used to initiate the test. Any defect should also be recorded in the Log Book and reported to the responsible person, and action taken to correct it.
- If the operation of the alarm sounders and/or the transmission of the alarm signal has been prevented by disconnection, then a further test should be carried out to prove the final reinstatement of the sounders, and if permissible, the alarm transmission circuits.
- The weekly test should be carried out at approximately the same time each week and occupants should be instructed to report any instance of poor alarm audibility. In premises in which some employees only work during hours other than that at which the fire alarms are tested, an additional test(s) should be carried out at least once a month to ensure familiarity of these employees with the fire alarm signal.

Monthly attention by the user

- If an automatically started emergency generator is used as part of the standby power supply for the fire detection and alarm system, it should be started up once a month by simulation of a failure of the normal supply and operated on-load for at least one hour. At the end of the test, the fuel tanks should be left filled and the oil and coolant levels should be checked and topped up if necessary.
- If vented batteries are used as a standby power supply, a visual inspection of the batteries and their connections should be made to ensure that they are in good condition. Action should be taken to rectify any defect including low electrolyte level.

Periodic inspection and Test by a competent person

Periodic inspection and servicing needs to be carried out by a competent person with specialist knowledge of fire detection and alarm systems, including knowledge of the causes of false alarms, sufficient information regarding the system, and adequate access to spares. The inspection and servicing is to be carried out in accordance with the maintenance recommendations described in British Standard 5839 Part 1.

The recommended period between successive inspection and servicing visits should not exceed 6 months and, in accordance with recommendations of the above British Standard, a contract between the responsible person and the competent person/servicing agent must be in place to make sure an agreement for emergency call out to deal with any fault or damage that happens to the system. The agreement should be such that, on a 24 hour basis, a technician of the maintenance organisation can normally attend the premises within 8 hours of a call from the user.

4.4 SELECTION PROCEDURES FOR BASIC FIRE EXTINGUISHING METHODS FOR BOTH LIFE RISK AND PROCESS RISK

PORTABLE FIRE FIGHTING EQUIPMENT

CLASS	IDEAL EXTINGUISHER	METHODS OF EXTINGUISHING
A	WATER (RED)	COOLING
B	FOAM (CREAM)	SMOTHERING
C	$C0^2$ (BLACK)	SMOTHERING
D	SPECIALIST POWDER	CHEM REACTION SMOTHERING
ELECTRIC	$C0^2$	SMOTHERING
CHIP PAN	FIRE BLANKET	SMOTHERING
F	BLANKET/AFFF	SMOTHERING

Water

- Water that can be applied as a spray or jet is the most widely used extinguishing agent but not suitable on flammable liquids as they will float and continue to burn.
- Cools burning fuels to below their flash point.
- Can be used to protect tanks which may be subject to heat.
- Cheapest medium but they have a limited range.

Dry Powder

This is effective on flammable liquids and electrical fires, a layer is formed which excludes the air and reacts chemically to extinguish the fire. It's economical for dealing with running fuel or gaseous fires and are suitable for indoor and outdoor use but can be messy to use. The powder is stored under pressure. The chemical is Sodium Bicarbonate and the extinguisher has a specially designed nozzle which releases a concentrated cloud.

Dry powder can also be supplied in polythene bags for use on metal fires. Special powders have been developed for metals and in particular radioactive materials. Most powder extinguishers are compatible with foam.

Foam

Water is mixed with foam concentrate, aspired into the air to cause expansion. Foam acts as a vehicle to transport the water to the surface of the flammable liquid. It cuts off the supply of oxygen and smothers the flames, cools the fuel surface and separates the fuel from the flames.

Foam is relatively insoluble because of its light weight so it floats on the surface and covers the burning liquid. Foam when used by the Fire Brigade is generated by soap, glue and some protein concentrates.

Aqueous Film Forming Foam (AFFF)

This film spreads rapidly ahead of the foam blanket, cooling the surface and cutting the air supply. Effectiveness of the foam depends on the type of flammable liquid, type of hazards and the size of hazard.

Carbon Dioxide

- Other inert gases, e.g. liquid nitrogen can also be used.
- Reduces the oxygen content of the air, 1-5 times denser than air, with minimal damage to materials.
- Suitable for liquids, solids or electrical fires - quick, nonconductive and non-toxic
- Not for use where items might re-ignite.
- Effective for use indoors.
- If used inside in large quantities it should be used in a well ventilated area.
- When discharged, liquid boils as a gas, extracting heat from atmosphere and smothering the fire.

4.4.1 Siting of Portable Extinguishers

Appliances should always be sited:-

- As close as is practicable to the fire risk
- Adjacent to exit doorways
- On escape routes
- At the same locations on each floor in uniform buildings
- Where possible, in groups forming "fire points"
- Where possible, in shallow recesses
- Away from extremes of temperature.

Portable firefighting equipment should be securely fixed to a wall with the carrying handles approximately 1 metre from floor level or placed on a purpose built floor stand. Persons wishing to use a fire extinguisher should not have to travel more than 30m in any direction to locate one. Fire blankets should be provided in high or special risk areas, e.g. all kitchens and where welding takes place.

4.4.2 FIXED FIRE FIGHTING EQUIPMENT

In addition to the provision of portable fire extinguishers there may be a need to consider the installation of fixed fire extinguisher systems to increase general fire protection facilities and/or to protect specific areas or equipment.

Water sprinklers, due to the effective extinguishing ability and accessibility of water, provide good general protection when installed within a majority of buildings.

However, in situations where the use of water could be hazardous or where it is essential to avoid or at least minimise water damage, or where special risks are present, the installation of alternative systems e.g. carbon dioxide, foam, or dry powder should be considered.

In Australia and New Zealand they have kept records for 100 years of fires in premises where sprinklers are fitted, 99.5% of fires in these buildings were controlled by the sprinkler system. Passive firefighting systems do not require the input of an operator to take action in the event of a fire or fire alarm.

Before deciding which type of system is to be selected and installed the type of workplace and fire hazards need to be identified.

Passive firefighting (those which do not require human input to activate them) systems include:-

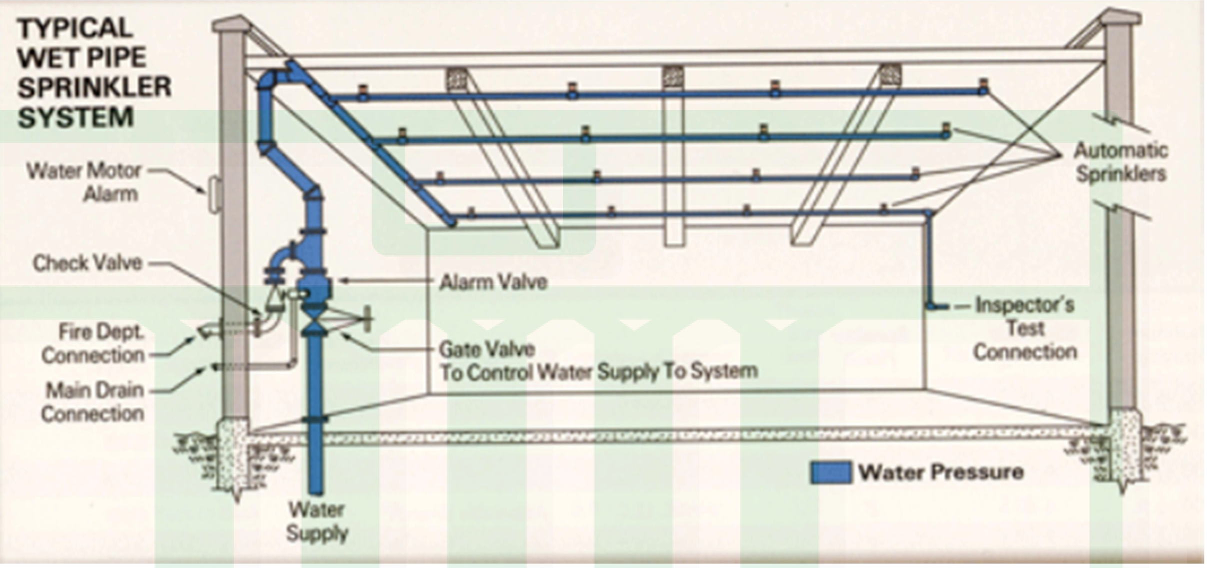
- Water sprinklers & Drencher and Deluge Systems
- Foam systems
- Carbon dioxide and other gas flooding systems
- Dry powder installations

a. Water Sprinklers

Water sprinklers comprise of a system of pipework, pumps, control valves and heat sensitive valves in the sprinkler heads which release water onto the fire. The rate at which the water is released will depend on the severity of the fire given the nature of any combustible materials present. It is the flow of water which actuates any connected alarm systems. In larger buildings it is usual to divide complete systems into "installations" which are separate from other sprinkler installations with each operated by their own control valves. Sprinklers are reliable and give constant protection, controlling and extinguishing fire.

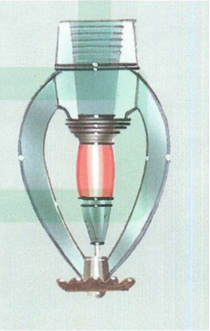
The installation may be:

WET - where all the pipes to the sprinkler heads permanently contain water. Only suitable in areas where the temperature will not fall to freezing levels.
DRY - where the pipework above control valves are filled with compressed gas to prevent the entry of water. On actuation, the gas releases allowing the water to discharge. Dry installations are used where there is a risk of frozen pipes.



ALTERNATE - where the installation is operated WET during the summer and DRY during the winter.

b. Sprinkler Heads



A clear space of at least 0.3m should always be maintained below the level of the sprinkler head throughout the room. For high-piled combustible stock, increased clearance of 1m or more should be provided.

Roof trusses should at all times be accessible to water discharged from the sprinklers. Sprinkler heads are thermally operated valves with a liquid filled glass bulb fusible link.

Regular inspections are required to be carried out. These should include sprinklers, controls, water installations, alarms, electrical supplies and back-up supplies such as diesel generators. The alarm valves, accelerators and exhausters in DRY pipe installations must be operated to ensure correct functioning (BS EN 12845: 2003). The electrical connections to the any fire brigade alarm should also be checked annually.

Image: *Sprinkler head and bulb colours – which react at different temperatures*

Sprinkler rating	Colour of bulbs	Sprinkler rating	Colour of bulbs
57ºC	Orange	141ºC	Blue
68ºC	Red	182ºC	Mauve
79ºC	Yellow	204 to 260ºC	Black
93ºC	Green		

C. Foam Installations

Foam installations are self-contained systems capable of making, conveying and releasing foam. The foam may be one of two types:

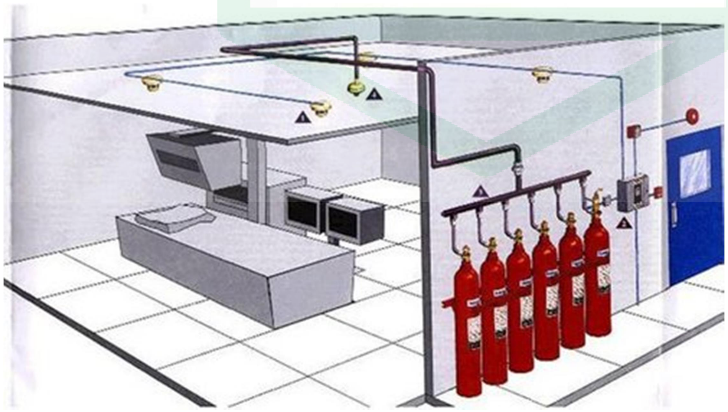
1 Low / medium expansion foam, suitable for flammable liquid fires where the liquid is immiscible (does not mix) with water. Special foams are necessary to extinguish water misci

2 High expansion foam suitable for general protection and especially in areas where accessibility Foam systems will operate automatically and may be connected to detector and alarm systems.

Image – Foam installation Activation

D. Carbon Dioxide Installation

The gas is usually stored in cylinders or is refrigerated, it is connected to the outlet nozzles by a system of pipework. Such systems may be designed to operate automatically (with the detector and alarm systems) or manually. Additionally plant shut down procedures may also need to be incorporated.



Carbon dioxide systems provide good protection for hazardous plant e.g. transformer areas, electrical equipment and flammable liquids. Computer rooms, control rooms and sensitive materials such as works of art may all be protected by carbon dioxide installations.

One disadvantage with these systems is the reduction of oxygen in the protected area on actuation, which necessitates built in warning and time delays to allow evacuation of the area. (British Standard 5306: Part 4: 2011: Specification for carbon dioxide systems).

E. Dry Powder installations

The dry powder is kept in a pressurised container or is connected to a gas cylinder with a system of pipework leading to the outlets. On actuation the powder becomes fluidised in the expellant gas (nitrogen or carbon dioxide) and is conveyed to the outlets.

These systems are suitable for fires involving flammable liquids, electrical equipment or where water damage must be kept to a minimum. (British Standard 5306: Part 7). They can be made up of individual units or large fixed systems.

F. Hose Reels

Fire hoses deliver plenty of water, and fire fighters use them to put out fires, so a fire hose would appear to be perfect for every commercial and industrial building. In fact they have been widely phased out in the last 20 years. This is because water does put out fires – of a particular type but can actually cause an increase in risks depending on the fuel source which is burning. Fire hoses can deliver high quantities of water but again this may actually create a hazard. Water should never be used to put out fires where there is a lot of live electrical equipment, or where burning liquids are involved.

- Water and electricity don't mix: bringing one into contact with the other will no doubt short the lights and plunge you into darkness, making matters worse than they already are.

- Water and burning liquids don't mix. For example, burning oil, in a chip pan fire, floats on water so putting water on it in an attempt to put it out will allow the burning liquid to spread, and will actually make the fire worse.

- Too much water: unlike a fire extinguisher, a fire hose is connected to the mains water supply, and will never run out of water. As a result, untrained people fighting fires with a fire hose reel tend to stay at the scene too long, trying in vain to put a fire out.

When a fire breaks out, the last thing anyone needs to be is a hero, and staying too long in a burning building puts your life at risk. Remember that, as long as it burns, a fire is probably pumping out smoke you can see and smell, and toxic fumes that you can't. If it's not under control in a matter of a couple of minutes, get out, and leave the fire fighting to the experts.

There are 2 main types of hose reel available and these come in many guises to suite the environment they are to be employed in.

Manual Hose Reels.

Manual hose reels require the user to turn on the water supply before deploying the hose, this normally means turning a tap mounted close to the reel. The tap would normally have a red top to identify that it is to do with fire although this is not a legal requirement.

Figure: Manual Hose Reel

Automatic Hose Reels

Automatic hose reels turn the water on as you pull out the hose, they contain a valve mechanism inside the drum which when the hose is pulled out the water is turned on and when the hose is wound back in the water is turned off. The normal turn to activate is 1-1.5 revolutions of the reel and 2.5-3 to close the valve. This reel has a valve but it does not have a tap on it instead it requires a special key to turn it off.

Figure: Automatic Hose Reel

Fire hoses are suitable for any area where there could be Class A fires, which involve quantities of 'ordinary' combustible materials, such as timber, paper, cardboard or fabric. However employees need to be trained specifically to operate the hose.

Fire hose reels come in standard lengths of 30 metres, and a diameter of 19mm. They deliver at least a third of a litre of water a second. Control nozzles are fitted to allow the water to be directed as accurately as possible, and to control the volume of flow. Most fire hoses should fitted with a ball valve shut-off device, a hose reel nozzle, and a mounting bracket. Hose reels are available with or without hoses already attached. Anywhere that water can accumulate and remain undisturbed for long periods is in danger of becoming a home for Legionella bacteria, and will need to be treated accordingly.

G. Fire Drencher Systems

Drencher systems may be differentiated from sprinklers in that they are designed to protect a building from damage by exposure to fire in adjacent premises. They are placed on roofs and over windows and external openings of a building. Drencher systems are a type of water or foam spray system. These are sometimes referred to as deluge systems or valves. Some industries, for example wood or paper processing, use infra-red spark detection in ducts and pipework; this can activate the water or foam spray system. A drencher system will have water heads similar to sprinkler heads and these may be sealed or unsealed.

Unsealed drencher heads will not be connected to an automated system and the water will need to be turned on manually by opening the main valve which will operate all open heads simultaneously. Sealed drenchers will actuate individually similar to sprinkler heads.

There are three main types of drencher:

- Roof drenchers will be fitted to the roof ridge and will throw a curtain of water upwards which will then run down the roof.

- Wall or curtain drenchers throw water to one side of the outlet and form a flat curtain over the openings or portions of a building most likely to admit fire.

- Window drenchers are used to protect window openings and provide a curtain of water which protects the glazing.

The controlling valves should be located in accessible positions on or near ground level. The position of each valve and the drenchers it controls must be clearly indicated by a wall plate.

Drench systems may prevent external firespread to adjacent buildings, but systems are reliant upon good maintenance. Drencher systems can create inhalable water droplets which may introduce a risk of exposure to legionella; however, the conditions normally found within well-maintained firefighting systems are not thought able to support the growth of significant populations of legionella.

Wet floors leading to slippery surfaces may result when they are used, there could also be reduced visibility due to smoke down drag by the water, along with water penetration through the building structure.

4.5 REQUIREMENTS FOR ENSURING ACCESS FOR THE FIRE SERVICE IS PROVIDED AND MAINTAINED

The Building Regulation requirement B5 concerns 'Access and Facilities for the Fire Service'. This covers a range of measures that are designed to assist the fire service in attending to an emergency. A certain proportion of the perimeter of the building needs to be accessible to a fire appliance, and no part of the building should be out of reach of a fire hose. If this is likely to be impossible to achieve (such as in high-rise buildings), then 'dry risers' need to be installed vertically within the building, to allow the fire service to connect their equipment. Very tall buildings may also need dedicated firefighting stairways.

'Vehicle Access' must be provided, this includes the following advice on access from the highway:
- there should be a minimum carriageway width of 3.7 m between kerbs;
- there should be a minimum gateway width of 3.1 m;

• there should be vehicle access for a pump appliance to within 45 m of every point within single family houses;
• fire service vehicles should not have to reverse more than 20 m.

The Association of Chief Fire Officers has expanded upon and clarified these requirements, they require 3.7 m carriageway (kerb to kerb) is required for operating space at the scene of a fire. Simply to reach a fire, the access route could be reduced to 2.75 m over short distances, provided the pump appliance can get to within 45 m of dwelling entrances; Changes to this must be discussed with local Fire Safety Officer.

Parked cars in the area can have a significant influence on response times. Developments should have adequate provision for parking to reduce its impact on response times; fire-fighting operations depend on a sufficient supply of water in order to control fire growth and assist in effective rescue operations.

The fire and rescue service should be provided with a water supply to assist with their fire-fighting and rescue operations. This is normally provided from public water mains through fire hydrants or alternative water supplies such as tanks or reservoirs may be provided.

In some cases, the existing water supply may be sufficient and there is no need to provide additional water supplies. Therefore, it is important to consult the fire and rescue service and water authority early in the design process to establish what water supply, if any, should be provided in order to carry out their statutory duties.

Practical Considerations

- Fire vehicles should not have to reverse more than 20m
- Flat level ground to allow access to the building(s)
- No tight bends or steep slopes which would stop fire vehicles
- Gates open or openable during an emergency
- Check gates can be opened / Gateways kept clear and unlockable
- Consider not only the width of access but also height restrictions

A. Fire Hydrants & Dry Risers

A fire hydrant is a piece of equipment that is fixed to a water main from which a firefighter can access water for firefighting. Fire hydrants are situated in footpaths or roadways and are protected by a rectangular metal cover marked FH.

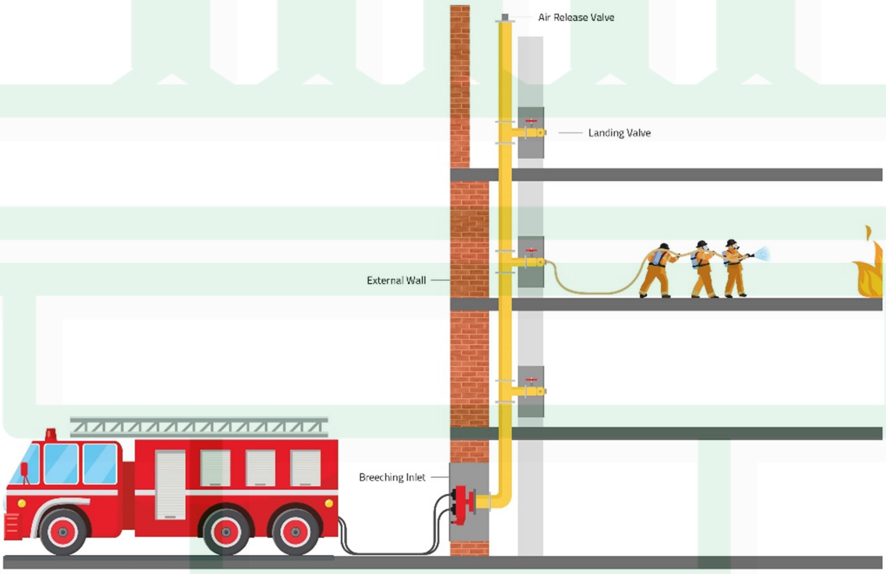
There are thousands of fire hydrants spread throughout the UK. It is the responsibility of the relevant fire service to ensure that these hydrants are ready for use should an incident occurs. They also work closely with the relevant Water Authority in relation the positioning of new hydrants.

Examination of fire hydrants is carried out at set intervals, determined by risk assessment. They will carry out repairs as appropriate and ensure that more serious defects are forwarded to the relevant Water Authority.

Image: Fire hydrant in use

Image: Dry risers installed in a building to allow fire service to attach its hoses

A dry riser is normally an empty pipe that can be externally connected to a pressurized water source by firefighters. It is a vertical pipe intended to distribute water to multiple levels of a building or structure as a component of the fire suppression systems.



B. Liaison with Emergency Services

It is important that when the emergency services arrive that the responsible person on site is able to provide as much additional information as possible, this could relate to anyone left in the building, the location and quantity of any high risk substances, the cause of the fire and any areas which are likely to present high risk. Information on any relevant sensitive environmental receptors may also be needed as firewater can create a range of different environmental problems which are explored in the next section.

4.6 STEPS TO MINIMISE THE ENVIRONMENTAL IMPACT OF FIRES AND FIRE-FIGHTING OPERATIONS

Most industrial and commercial sites have the potential to cause significant environmental harm, these may increase if a fire occurs. Rivers, sewers, drains, water distribution systems and other services all present routes for the conveyance of pollutants off-site and the effects of a discharge may be evident some distance away. Contingency planning is the key to success and both preventative measures and incident response strategies need to be carefully addressed. In the event of an incident the Environment Agency must be contacted immediately.

Picture: From the Buncefield fire, the white material is the fire fighting foam which by now will be heavily contaminated.

If a major fire occurs there will be air pollution in the form of smoke, gases and vapours, water pollution from leakages and fire water along with land contamination from substances entering the surrounding land. This may include air pollution coming down to ground level effecting wildlife and animals.

One of the major considerations is the pollution risks to water resources from contaminated fire-water. This may run off the site into nearby rivers or streams, enter via discharge points on site which travel to nearby water courses, through soakaways and into the sewage system via foul drains.

All smoke is hazardous to breathe. Smoke is a mix of particles and chemicals produced by incomplete burning of carbon-containing materials. Fire smoke is very concentrated and poses more of an immediate, short-term health concern to someone breathing it.

Even with the best of environmental and H&S management systems emergencies may arise, to protect both itself, its employees, neighbours and reputation the organisation need to ensure they have effective emergency plans in place. Having the plans alone is not sufficient they must be tested and reviewed to ensure the day they are required they are actually followed. Workplaces with large scale operations involving hazardous substances will be covered by specific legislation, but every organisation needs to have emergency plans where there are risks to the environment.

4.6.1 Legal obligations related to environmental protection in the event of a fire, role of the Environment Agency

Where an incident has occurred with has either damaged the environment or has the potential to do so it should be reported to the environment agency. Typical issues which need to be reported include:-

- Damage to the natural environment
- Water pollution

- Land pollution
- Dead fish spotted in a stream
- Water course blocked and causing a risk of flooding
- Waste being dumped
- Collapse of a river bank.

Water Resources Act 1991

Section 104 of Water Resources Act 1991 defines controlled waters. They cover virtually **all** fresh and saline natural waters out to the offshore UK territorial limit, including:

- rivers and streams;
- canals;
- relevant lakes and ponds, and certain reservoirs;
- estuaries and coastal waters;
- ground waters (water table).

The protection of controlled waters and discharges into them is the responsibility of the Environment Agency or in Scotland, SEPA. Under the Water Resources Act 1991 it is an offence to cause or knowingly permit any poisonous, noxious or polluting matter or any solid waste matter to enter any controlled water or to breach the conditions of a consent. This would include fire water which causes harm to any controlled water.

Penalties include fines, imprisonment, with the agencies able to take direct action to protect the natural environment if there is a major emergency such as a fire.

4.6.2 Factors to be considered in pre-planning the minimisation of environmental impact of fire

The type and extent of the measures implemented at a major hazard installation to protect the water environment from the effects of an accident will depend on the likelihood of an accident occurring and the likely consequences. The likelihood of an accident occurring depends on the nature and quantities of the hazardous substances on site, the activities carried out on site and existing accident prevention measures. The environmental consequences of an accident will depend not only on the severity of the accident but also on the nature of the environment in terms of the flora and fauna which it supports and its ability to recover if damaged.

The health and safety of people is always paramount and it is important to consider indirect risks to people. Environmental contamination may result in long term exposure to hazardous substances, which may enter the food chain via the air, water or soil. Decisions may have to balance the risks due to airborne pollution if a fire is allowed to burn and risks to the environment if water is used to control it.

It is important to assess the routes by which contaminants can be carried significant distances away from the site, where they may cause serious environmental contamination, for example drainage systems and rivers and it is important that suitable 'water maps' are prepared showing the location of all drains, water supplies and water courses. Smoke plumes may carry significant quantities of pollutants away from the site; knowledge of prevailing weather conditions, including mean wind speeds and directions is required to assess this effect.

Many industrial and commercial sites have the potential to cause significant environmental harm which could threaten water supplies, public health and wild life in the event of an environmental incident for example fire, explosion or spillage.

Image: showing use of booms to prevent spread of contaminated liquid

Fire incidents could affect:

- drainage systems, surface waters, aquatic ecosystems, groundwater and soil;
- air quality by producing toxic fumes and airborne pollutants which may damage human health,
- wild and domestic animals and ecosystems;
- thermal radiation which can harm people and the environment.

The impacts may be immediate and long lasting; the employer may be responsible for the costs of clean-up. This can be expensive particularly if groundwater is contaminated.

4.6.3 Dealing With Fire Run Off

Most industrial and commercial sites have the potential to cause significant environmental harm, they may generate harmful run-off generated in the event of a fire. The environmental damage may be long term and, in the case of groundwater, may persist for decades or even longer.

Picture : Fire Fighting at Buncefield 2005

Containment Lagoons

Where the site topography and the ground and soil conditions are suitable, earth banked containment basins (or lagoons) can provide cost effective, remote secondary containment systems, particularly for the retention of firewater. Lagoons may be constructed either above or below the surrounding ground level and formation level is often determined by the economic advantage of balancing cut and fill.

To protect groundwater, the lagoon should be substantially impermeable. In some situations this will require the use of an impermeable membrane or other suitable liner to ensure that it does not leak in the event of an incident occurring. In situations where a membrane is not required, it is recommended that a minimum of 1 metre of engineered clay, with a maximum permeability of 1x10-9 m/sec, is used to line the lagoon.

Lagoons should be constructed so that they can be isolated in an emergency from the main drainage system. Flood defence installations, such as a balancing lagoon or shared, off-site flood storage facilities may be used to contain fire-fighting run-off, providing that they incorporate shut-off devices. If pumped storage or transfer facilities are in use, a back-up power supply should be considered.

Tanks (Temporary or Fixed)

Purpose-built tanks may be used for the containment of fire-fighting run-off or spillages. Although most tanks are not designed specifically for the containment of spillages or firewater, the UK standards for liquid storage tanks and vessels are high and many of these are suitable for use as secondary containment. They may be more expensive to construct than lagoons, but this can be offset by the smaller land area required. In addition, a tank may facilitate firewater reuse in appropriate circumstances.

Below Picture of brick built containment tank.

Shut-off valves and penstocks

Shut-off valves or penstocks which can isolate part or the whole of a site facilitate the retention of spillages or fire-fighting run-off on site. Their effectiveness depends on the capacity of the drainage system. They may be operated manually or triggered by means of automatic sensors. As a general rule, simple systems are best.

Automatic sensors and closure devices may be used to ensure a rapid response on sites where an incident might not be immediately noticed. It is vital that such devices are properly maintained and regularly tested. In the event of an incident, it is essential to verify that they have functioned properly as soon as possible, either by inspection or the use of telemetry.

Picture Penstock which can be shut if there are any discharges which need to be stopped from entering the river

4.6.4 Site and damaged area clean up consideration.

The damage fires inflict on businesses and homes is often devastating and can leave premises unusable and uninhabitable for long periods of time. The immediate visual damage caused by a fire can be distressing enough without the secondary effects such as soot odour, health problems and corrosion.

It is essential that fire damage is cleaned up immediately as not only does it cause financial loss, but failure to do so can lead to further deterioration of buildings and equipment
When a fire occurs, porous surfaces expand allowing the soot and odours to enter. Once the surface begins to cool, the pores will then close, trapping in the soot and odours. If the removal and cleaning of this fire damage is not carried out correctly, when the air temperature rises, this soot and odour can migrate back to the surface.

Picture Buncefield 2005

Smoke from fires often travels from hot and cold areas, high pressure areas to low pressure areas meaning the resulting soot damage often spreads far from where the initial fire began, increasing the area that needs to be specially cleaned to prevent future problems occurring. The earlier a fire can be tackled, the greater the chance of successfully extinguishing it and minimising the quantity of contaminated water. Contaminated land may need to be removed as hazardous waste or treated in situ. If any fire water has run off into a river or stream steps may be needed to treat the pollution and prevent it spreading via the use of booms.