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Fires in the built environment

and

Fires in buildings under construction or demolition

Knowledge and information

Version 1.5

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Version history

Date	Version number	Summary of changes
11/08/14	1.1	Initial publication
22/01/15	1.3	This version incorporates some minor wording changes, at the request of the Fire Brigades Union, to provide additional clarification in the knowledge sheets for: • Smoke control – Smoke curtains • Structural frame – Timber • Windows – Glazing
02/11/15	1.4	Addition of knowledge sheets to support the guidance for fires in buildings under construction or demolition: • Construction or demolition sites • Scaffolding • Temporary accommodation units • Incomplete buildings and structures • Legislation Topics sorted into alphabetical order
16/02/16	1.5	Amendments to knowledge sheet for scaffolding to avoid conflicts with the Incident command guidance

Ancillary features
False chimneys
Description False chimneys are installed on roofs of properties which want the appearance of a chimney but there is no fireplace in the property. These are generally found on modern buildings (circa post-2000).

General considerations	
A false chimney is built into the structural members of the roof with the normal roof covering placed around it. Generally a metal or plastic frame is used which is clad with a brick or render facing. False chimneys can be fixed on the ridge, mid-pitch or gable-end of a building. The ability of a false chimney to stay in place is heavily reliant on the roof structure to which it has been fixed. If the roof structure is affected by fire this can weaken the roof joists and the roof may no longer support the weight of the false chimney.	
Inherent benefits	**Inherent hazards** Difficult to recognise. If the roof to which a false chimney is connected suffers damage this can result in the chimney falling through the roof joists to the floor below or off the roof. False chimneys are not suitable as an anchor for working at height as they may not be able to support any additional weight.

Fire and rescue service considerations
 	
• Identify the presence of false chimney:
    ○ Consider examination of similar property
    ○ Information gathering from residents
    ○ Absence of internal stack	

References Generic risk assessment 3.3: fighting fire in domestic chimneys Fire Service Circular 38/2009, Timber Framed Buildings, and related training package from London Fire Brigade	

Ancillary features
Green roofs and walls
Description Green roofs and walls, also known as 'living' roofs and walls, are external roofs and walls that are purposely cultivated with vegetation, commonly for decorative and/or environmental purposes.

General considerations

Green roofs can be either planted with simple plants (known as extensive) or shrubs and trees (known as intensive). In general the green roof or wall consists of several layers of membranes and barriers which separate the growing medium, from which plants grow, from the structural building elements. Installation guidelines for green roofs state that there must be adequate fire separation in place, especially around openings.

There are several types of green or 'living' walls:

- supported by a wall e.g. self-supporting climbers
- supported by a structure on a wall e.g. climbers on a trellis or wires
- purpose-made modules or blankets which are irrigated and which support a wide range of plants

Inherent benefits	**Inherent hazards**
Access should be provided to green roofs for maintenance reasons.	When dried out, green roofs and walls can be a source of fuel for a fire, allowing external firespread. Green wall frames or modules may fall off the wall onto personnel below.

Fire and rescue service considerations

- Consider removal of vegetation to prevent external firespread
- Consider water spray for suppression, evaluate applied weight of water on roof structure
- Consider compressed air foam (CAF) as a fire break or suppression

References

CIBSE KS11 Green Roofs (CIBSE Knowledge Series 11)

Fire Performance of Green Roofs and Walls, Department for Communities and Local Government, August 2013

Designing for Biodiversity: A Technical Guide for New and Existing Buildings (2nd edition) – Brian Murphy, Kelly Gunnell and Carol Williams, RIBA Publishing, August 2013

Ancillary features
Luminous discharge tube ('neon') signs
Description Luminous discharge tubes or 'neon' signs, as they are more commonly known, tend to be found installed on the external walls or roofs of commercial properties.

General considerations

These signs work using high voltage electricity to excite a gas within the tubes. This gas will not always be neon and the tubes will more commonly contain argon gas with a small amount of mercury, which is a toxic substance. When energised this creates a mercury vapour which can be released if the tube fails.

Inherent benefits	**Inherent hazards**
'Neon' signs should have a manual override or firefighter switch installed. Easily recognisable.	Risk of electric shock with potentially high voltages. Exposure to mercury vapour or other hazardous substances. Signs can become unstable and fall. Concealed firespread can occur where high voltage cabling is either affected by fire or may have caused the fire.

Fire and rescue service considerations

- Ensure signs are isolated from electricity supply before working on or near them
- Handle any signs that need removing with care consider the use of breathing apparatus (BA)
- Consider the need for working at height procedures or aerial appliances
- Check mountings for concealed areas due to potential undetected firespread
- Consider the use of thermal imaging cameras
- Consider cutting away to expose areas affected
- Consider post incident welfare monitoring if lighting tubes are damaged during removal

References

Generic risk assessment 5.1: incidents involving electricity

Ancillary features
Microgeneration renewable energy technology
Description Micro-scale renewable energy technologies are becoming more common for installation or incorporation onto buildings. These technologies include photovoltaics (PVs), solar thermal, micro-wind turbines and heat pumps.

General considerations

In general these systems transform energy from the sun, wind or geothermal sources and convert it into a source of energy for the property on which they are installed, either as electricity, power or for heating the property.

There are some common hazards associated with these systems as they are generally installed onto the external envelope of a building and hence pose a hazard for non-structural collapse and this may in turn cause structural collapse.

Photovoltaic (PV) systems

Photovoltaic (PV) panels (also called solar electric panels) convert energy from the sun into electricity. For building applications, a number of PV panels are normally connected together to form a PV array, and most panels are currently being fitted to existing roofs or walls using an external framework.

PV panels (or modules as they are sometimes called) are composed of a number of PV cells (or solar cells) containing a photovoltaic material and these can be in a variety of shapes and sizes.

Photovoltaic panels generate electrical power by converting solar radiation into direct current (DC) electricity which is turn is converted to alternating current (AC) electricity by use of an inverter. A typical domestic system would be rated at 2 – 4 kilowatts-peak (kWp), whereas commercial roof-mounted systems can be from domestic size up to 1000 kWp for very large area roofs.

PV arrays can create DC at elevated voltages and it is not normally possible to completely isolate the DC electrics between the PV array and the DC isolation switch. Additionally, PV modules are current-limiting devices meaning fuses are not likely to operate under short-circuit conditions which could mean a fault in the system goes undetected. This scenario can present electric shock risks, although these can be minimised by good system design, product selection and installation practices.

In the event of a failure of the AC supply to a building, (for example due to a local power cut, or a fire) the inverters are designed to shut down automatically. However, the solar DC supply (from panels to the DC isolator) will still be live during daylight. It may therefore still be necessary to manually isolate the DC cables and components from the PV panels which will otherwise remain live. For most installations the isolation switches for DC cables are situated in the roof void.

If a fire damages the DC cables from the PV array, for example by burning off insulation, then there will be risk of electric shock from the exposed DC conductors, in particular to firefighters.

PVs will work, to some extent, in any weather as long as there is daylight and so can still generate some electricity on a cloudy day.

Concerns have been raised regarding the presence of heavy metals within some specific types of PV cells, and whether such metals can be or are released during a fire. Therefore, while such risks are considered to be low, caution is needed, as with any fire involving electronic elements, in dealing with fire damaged components and residues since a variety of heavy metals and other toxins may be present.

There is a variety of more specialised panels designed to form part of the building covering, for example building integrated panels, solar tiles and glass facade components are available. These products are collectively known as Building-Integrated PV (BIPV) and should be considered as a roof covering.

Solar thermal

Another type of renewable energy technology can have the appearance of PV panels but operate differently. Similar to PV systems solar thermal systems are installed onto the roofs of properties. Solar thermal systems convert energy from the sun into thermal energy for the property through a “collector”. This “collector” can be a panel or tubular system. Unlike PV systems, solar thermal systems use the collected energy to heat a transfer fluid which in turn is stored and then used to heat the property. This heat transfer fluid will contain antifreeze and can reach temperatures of ~200°C and the system can have pressures of up to 6 bar.

Figure 1: Solar thermal system

Micro-wind turbines

These are small scale building-mounted wind turbines which are used for the generation of electricity. The turbine is mounted on a pole which is fixed with brackets onto an external wall or onto a roof or through the roof via a steel frame located in the loft. Similar to PV systems, the electricity generated by wind turbines is DC which is converted to AC by an inverter. Wind turbines are installed with both a wind-turbine controller, which can stop the blades turning in high winds and an isolation switch which allows for safe maintenance or repair.

Figure 2: Micro-wind turbine

Heat pumps

Heat pump systems work by extracting heat from the surrounding air, water, or ground. These systems are designed to heat a whole building and operate using the same principles as a refrigerator. They require electricity to power the pump; however, the electricity required might be generated by a small wind turbine or PV panel. There are three main types of heat pump, ground source, air source and water source. These systems do not have any known specific hazards to firefighters.

Ground source heat pumps

Ground source heat pumps make use of the ground’s constant temperature by converting and transferring this heat into a house or building, usually via radiators or underfloor heating. Ground source heat pumps use pipes which are buried in the ground to extract heat from the ground. A ground source heat pump circulates a working fluid (usually a mixture of water and antifreeze) through a loop of pipe (a ground loop) buried in the ground. Heat from the ground is absorbed into the fluid and then passes through a heat exchanger into a heat pump.

Air source heat pumps

An air source heat pumps extracts heat from the outside air in the same way that a refrigerator extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C. Heat from the air is absorbed at low temperature into a working fluid. This fluid then passes through a compressor where its temperature is increased, and transfers its higher temperature heat to the heating and hot water circuits of the premises. The heated air can be circulated around a building via ***ducting***. These systems are usually mounted on an external wall close to the ground.

Water source heat pumps

Water source heat pumps use the energy in water to provide heat suitable for homes or buildings. The pump system takes heat from the water and transfers this heat to a gas. The gas is passed into a condenser that returns it to a liquid state, a process that releases heat. This heat is transferred to the heat distribution system in the home or building.

Inherent benefits

Some systems will have isolation switches installed.

Micro-wind turbines

Easily identifiable as located at a certain height above the roof.

If the blades are not rotating then no electricity is being generated.

Heat pumps

No specific hazards.

Inherent hazards

General

There is the risk that the installations e.g. panels, glass from the panels, solar tubes, micro-wind turbines or blades from turbines may break and fall onto personnel below.

These installations may not be easily identifiable and may be hidden (flat roof).

May not be evident whether a panel is PV or solar thermal and these have different hazards associated with them.

Arrays for PV or solar thermal which are stood off from the roof may cause a channelling effect, thus exacerbating a fire affecting the roof.

Should the roof of the building be affected by fire, then the additional mechanical loading due to the weight of the installation, or additional wind-loading caused by the installation, may cause early collapse of the roof.

Poorly installed systems may obstruct or restrict use of roof windows as means of escape or hinder firefighting operations.

There may be restricted access to isolation switches.

General electric shock risk from PV systems, wind turbines and heat pumps. PV systems and wind turbines generate DC electricity.

PV systems

Electric shock:

- There are potentially very high DC voltages (up to 1000 volts DC in large installations) which are more dangerous than car electrics and normal (AC) electrical installations.
- Parts of the system are always live while light falls on the panels (artificial lighting may generate small currents).
- If the build is metal, or steel frame, then an accidental short may result in parts of the building being "live".
- There is the risk of electric shock if cables are cut or become damaged by fire.

The panels can get hot (from the sun) with a (minor) risk of burns.

Possible exposure to heavy metals.

Solar thermal

Failure or breakage of the panel or tubes can result in hot fluid (>200°C) or steam being released which can cause scalds or burns. This fluid can be present at pressures up to 6 bar.

Wind-turbine blades

Risk of electric shock if blades are spinning and wiring is damaged.

Heat pumps

General electrical safety applies.

Fire and rescue service considerations

- Identify if sources of renewable energy are fitted to building
- Consider that there is:
  - potential of PV panels and turbines to continue generating electricity at very high voltage
  - the potential of escaping hot liquid in solar thermal panels
- Integral roof or window elements may produce electricity
- Request specialist advice to isolate the system
- Prevent blades from rotating to prevent electrical generation

References

Shipp, M et al. Fire safety and solar electric/photovoltaic systems. BRE. October 2013.

Generic risk assessment 5.1: incidents involving electricity

Blackmore, P. Guide to installation of renewable energy systems on roofs of residential buildings. NF30. NHBC Foundation. July 2011.

Shipp, M and Manchester, S. Assessing the Fire Risks of Renewable Energy Technologies. BRE Trust.

Ancillary features

TV aerials and satellite dishes

Description

These are devices that are attached to a building for the purpose of receiving broadcast signals.

General considerations

TV aerials are usually found either in the roof space of a building or affixed to chimneys or the top of external walls, particularly gable ends. Satellite dishes are usually found on an external wall facing south. Given the prevalence of television ownership, it should be assumed that most domestic buildings will have either an internal or external TV aerial.

The ability of TV aerials and satellite dishes to stay in place is reliant on the structures to which they have been fixed, and the fixings used. If these are affected by fire then they will no longer support the weight of the aerial or dish, which may then fall.

Inherent benefits	Inherent hazards
Can be easily identifiable.	If the structure to which a TV aerial or satellite dish is connected suffers damage then this can result in the item falling. Failure of fixings may also result in the item falling. TV aerials and satellite dishes are not suitable as anchors for working at height as neither they nor their supports are designed to support additional weight. TV aerials and satellite dishes that are not properly grounded may present a risk of electric shock from the build-up of static electricity. Rooftop aerials may attract lightning strikes during a storm.

Fire and rescue service considerations

- Consider isolating supply, for example on powered satellite dishes

References

Area
Floor area
Description The total floor area of the building across all levels.

General considerations

Buildings with large floor areas are commonly sub divided into fire compartments which are provided by lines of fire compartmentation.

Complex buildings with a large floor area, often have refuge areas or floors which are protected by fire resisting construction and allow the occupancy to temporarily remain within the building.

However, some buildings, such as those which are sprinklered, single storey, fire engineered, or are offices may not be subdivided by fire resisting construction.

Buildings with large floor areas which are not subdivided by fire resisting construction have the potential for increased potential for firespread across and between floors.

Large undivided floor areas can allow a smoke layer to cool and descend as it travels away from the fire seat of the fire, reducing visibility.

Complex internal layouts, partitions, gantries, storage, equipment and machinery can further extend travel distances and make way finding difficult.

Buildings with a large area should have access to the majority of the perimeter for firefighting appliances.

Where fire engineered solutions have been adopted to support large open areas, these can rely on other fire safety systems such as smoke control, control of fire loading, or sprinklers to control fire and smoke spread.

Multi-storey buildings with a large floor area commonly incorporate firefighting shaft for firefighting access.

Older buildings may have been extended or connected to increase the overall floor area. There could be a variety of construction methods within the same area which could perform differently in a fire event.

Inherent benefits	**Inherent hazards**
Good building controls are likely to be in place for buildings with an area more than that dealt with by Approved Document B.	As area increases, potential fire size, access and travel distance issues increase. As area increases, the potential complexity of the building increases. In buildings with larger floor area, the seat of the fire may be difficult to locate if there is a lack of ventilation. Smoke cooling could reduce tenability in areas remote from the seat of the fire. Firefighting shafts may not be provided to ensure hose reach coverage to all areas of the floor area.

Fire and rescue service considerations
• Identify appropriate access and egress to reduce travel distances
References
Approved Document B BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings.

Construction or demolition

Scaffolding

Description

Scaffolding may be used to provide a temporary or semi-permanent means of access, working platforms, spectator terraces (also refer to demountable structures), or as stability to structures under construction or demolition.

General considerations

Scaffolding, from the perspective of construction or demolition activities, is predominantly a system designed to enable safe working at height, but can be used as a means to provide stability to buildings or structures and not for use as access. There are two generic types of scaffolding systems:

Tower scaffold – this is an independent scaffold, which is standalone and is often moveable with provision of outriggers for stability. However, these scaffolds may be tied to the building if outriggers cannot be used or if there are issues regarding prevailing wind speeds.

Fixed scaffold – this is formed of tube and fittings or modular systems that lock together and is normally tied or anchored to the structure under construction or demolition. Tie methods will be via window openings or eye-bolts drilled and fixed using nylon plugs.

Commonly the structural components are steel or aluminium with metal or timber access platforms (planks). There is normally no additional fire resistance afforded to the system. Aluminium is particularly used to span openings such as shop fronts or across fragile roofs due to its reduced weight. However the low melting point of aluminium (660°C) means it will rapidly lose its strength when exposed to fire.

Scaffolds should be continually boarded with no gaps or openings, and have toe boards and guard rails.

Scaffolds may contain staircases to provide emergency escape. These may be constructed from scaffolding with timber treads or purpose-made all-metal escape stairs. These may provide suitable access and egress, subject to an appropriate risk assessment.

Technical guidance for the erection of scaffolding is available and should be followed – refer to the Health and Safety Executive guidance for scaffolding. This guidance includes information about certification of any system designed and installed for use on a construction or demolition sites.

Incomplete scaffolding systems (that have not been certified for use) should be clearly marked to prevent their use.

It is possible for scaffolding systems to be designed to provide stability to the structure under construction or demolition. These will not necessarily provide support to the structure as they will not take the load of the structure, and they may not provide access. A system that is not designed to provide access should be marked accordingly.

Figure 3: Fire retardant certification mark

Scaffolding systems commonly incorporate netting or sheeting to prevent items falling from them or to provide protection from the weather. These can present risks to firefighters as they can obscure vision, facilitate firespread or can be a entanglement hazard. There are systems available which are fire retardant and can reduce firespread up the façade of the building – these will have a certification mark as shown in figure 3.

Scaffolding, when used as a working platform, may also be used for storage of materials (such as bricks or blocks) and plant machinery. They may have lighting systems for illuminating work areas.

Systems may incorporate vertical motorised lifts for access and/or transport of material, although these are normally anchored to a structure rather than to the scaffolding system. These lifts should not be used during a fire and may be designed to only transport equipment or building materials.

Inherent benefits	**Inherent hazards**
Completed systems will generally be certified for use and this information should be available via the site's competent person. Can provide a means of access for FRS personnel – subject to an appropriate risk assessment. Scaffolding should have weekly written inspections. Scaffolding tags may provide information about the structure and the scaffolding provider.	Scaffolding systems may collapse rapidly and independently of the building, depending upon the severity of the fire. The behaviour of aluminium and nylon plugs should be considered in this regard. Not all scaffolding systems are load-bearing. Presence of scaffolding systems can worsen the fire, particularly where there is non-fire retardant sheeting or netting. Netting can become loose during a fire and may present an entanglement hazard. The behaviour of scaffolding in fire is unpredictable and its use during a fire must be subject to an appropriate risk assessment.

Fire and rescue service considerations

- Consider the potential for early or sudden collapse
- Scaffold may collapse beyond the site boundary, fencing or hoarding
- Collapsing scaffolding may affect or pull down other elevations of the building to which it is attached
- Ensure cordon distances consider outward collapse
- Scaffolding elements may contribute to fire loading and external firespread
- Scaffolding should only be used following liaison the with scaffolding provider or competent person and appropriate risk assessment being carried out
- Identify the presence of external netting as it may:
  - Obscure light and/or vision
  - Facilitate firespread
  - Present an entanglement hazard
  - Restrict access and egress during rescues

References

Health and Safety Executive - Scaffold checklist

National Access and Scaffolding Confederation TG 20:13 Good Practice Guidance for Tube and Fitting Scaffolding – http://www.nasc.org.uk/

Construction or demolition
Construction or demolition sites
Description Construction or demolition sites are areas where the work activities associated with the construction or demolition of buildings or structures take place. This knowledge sheet is concerned with the operational aspects of construction sites. Structural or fire safety issues of incomplete buildings or structures are dealt with in a separate knowledge sheet.

General considerations

Construction or demolition sites can be extremely hazardous places due to the work activities taking place and the general environment.

Construction or demolition sites incorporate five key components:

Site enclosure – Includes systems to manage the security of the site such as hoarding or security fencing. This is used to prevent unauthorised access to mitigate any injury to unauthorised persons. This also includes adjacent land usage which may have an environmental protection impact, or be affected by radiant heat from a fire in the construction site. The terrain of construction sites can result in unstable ground that may to present hazards to fire and rescue service personnel. There can be concealed physical hazards such as trenches.

Traffic management – Construction or demolition sites will normally have plant and machinery on site. These may restrict access to the fire or pose a hazard while firefighting.

Waste and materials management – This includes storage of large quantities of combustible materials, hazardous materials for use in construction or demolition and waste from the work activities on site. Hazardous materials can include substances which can worsen the fire conditions, for example flammable materials or gas cylinders, or could be waste materials such as asbestos.

Temporary accommodation units – These may incorporate site welfare facilities, storage units and offices.

Temporary structures or structural support – These include scaffolding and incomplete buildings or structures.

Inherent benefits	**Inherent hazards**
Access to the site should be controlled, therefore of low risk to members of the public. Site enclosure can provide a cordon for the incident. Site layout plans should be readily available from a site manager. Sites posing particular hazards (for example timber frame) should be registered with the fire and rescue authority and/or CFOA.	Rough terrain, unstable ground and concealed physical features can present hazards of slips, trips and falls or issues with stability of structures and/or suitable ground for anchoring appliances. Traffic management may be necessary. Sites will constantly change and previous site familiarisation visits may be invalid at the time of an incident. Hazardous materials or gas cylinders may be stored on site and if near the fire may present a hazard to fire and rescue service personnel.

Fire and rescue service considerations
• The site may be well-secured, making access and egress for the fire and rescue service difficult • Liaise with the Responsible Person, or appointed competent person, to assist in the identification of work activities, site hazards and the control of on-site vehicle movements • Incident commanders should avoid relying upon experience from dealing with fires in completed buildings and proceed with caution • Liaise with the Responsible Person, or appointed competent person, for up-to-date site risk information. For larger construction sites, this should include risk information as prescribed by the Construction (Design and Management) Regulations 2015 (CDM 2015) and the Fire Prevention on Construction Sites 9th edition. • Consider the potential for firespread to adjacent buildings • Site hoarding or fencing can provide a natural cordon, but consideration should be given to collapse occurring and affecting surrounding areas outside of the site boundary • Consider the presence or involvement of hazardous materials, including asbestos
References
HSG150 – Health and safety in construction HSG168 – Fire safety in construction Construction (Design and Management) Regulations 2015 (CDM 2015) Fire Prevention on Construction Sites 9th edition – Construction Industry Publications Ltd/Fire Protection Association, October 2015

Construction or demolition
Temporary accommodation units (TAUs)
Description Temporary accommodation units (TAUs) are often located in or around construction or demolition sites. They primarily provide offices, canteens and welfare facilities used by people working on building sites. TAUs can vary from very simple single mobile units to complex multi-storey composite units. TAUs are usually situated in the open air, but can be located inside structures.

General considerations

Temporary accommodation units, where located in or around a construction or demolition site, provide temporary office accommodation and welfare facilities for site staff.

They are often located along a safe access route from outside of the site enclosure in order to facilitate safe visitor access. However, they can be located within existing buildings, or use part of an existing building as the accommodation itself.

TAUs may be identified with signage such as 'Site Office' or 'Canteen'. However, their general appearance may not be easily identifiable; for example, a converted ISO shipping container or a part of a building could be fitted out with temporary partitions.

TAUs typically comprise modular units, whether constructed as 'Portakabins', ISO containers, mobile homes or other purpose-built structures. The location of the temporary accommodation units may change during the site activities. Due to the temporary nature of the structures they may not be subject to the requirements of the Building Regulations 2010. Therefore normal fire safety provisions, as found in typical offices and associated accommodation, may not be provided by the structure itself.

However, as a place of work, all TAUs are subject to the requirements of the Regulatory Reform (Fire Safety) Order 2005 and therefore the risks present within the buildings should be managed to acceptable levels.

The fire hazards present within TAUs are similar to those of office environments. However, hazards may be increased due to the lightweight nature of these structures, the storage of hazardous materials or the presence of sleeping accommodation and cooking facilities.

Inherent benefits	**Inherent hazards**
The construction site's health and safety file would normally be located within the TAU. There should be a safe access and egress route to the TAU from outside the site enclosure.	The TAU may include complex access and escape routes when either multi-storey or located within existing buildings. There may be high fire loading due to poor housekeeping in the TAU. The TAU may be used inappropriately, for example storage space may be used as sleeping accommodation. Catering and office facilities may include LPG, and other pressurised vessels, for cooking or heating. The electrical supplies may be a temporary installation, separate to the remainder of the site and incorporate loose cables/fixings.

	Hazardous materials may be present.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, for up-to-date site risk information about the TAUs and consider what they are being used for
- Consider unauthorised use, for example as sleeping accommodation
- Consider the potential for rapid firespread and early collapse
- Consider isolation of utilities; isolation of electricity in one part of the site may not guarantee isolation of all TAUs. Electricity may also be provided by a generator.
- Consider the presence or involvement of hazardous materials, for example, flammable liquids, pressurised cylinders and effluent tanks

References

CFPA-E No 26:2010 F – Fire protection of temporary buildings on construction sites

http://www.cfpa-e.eu/wp-content/uploads/files/guidelines/CFPA_E_Guideline_No_26_2010_F.pdf

HSG168 – Fire safety in construction

Construction or demolition
Incomplete buildings or structures
Description An incomplete building or structure is one where the building or structure is only partially completed, is undergoing works or is partially deconstructed. This leads to exposed elements of structure, which in a complete building would generally incorporate passive fire protection. Furthermore, active fire protection systems required by the design may not be present or functioning.

General considerations

Incomplete buildings and structures can be extremely hazardous during firefighting operations due to lack of fire protection features.

Buildings during construction or demolition will undergo various stages of completion. As such, the various fire safety precautions afforded in a completed building may not be present and/or commissioned or decommissioned.

All hazards in the Fires in the built environment guidance are relevant to incomplete buildings and structures – the risk of the hazard occurring may be increased due to the nature of the building or structure under construction or demolition.

There is a potential for increased firespread through an incomplete structure, compared to a completed structure, due to lack of normal fire safety precautions such as compartmentation. An incomplete structure may be open to the elements, for example due to a lack of windows, which affords more ventilation that can worsen the fire conditions.

The incomplete nature of the building may expose structural elements like connections, combustible materials normally fire protected and/or the structural frame be it timber, steel or concrete. Such exposure can weaken the structure and lead to early collapse.

The structure may have scaffolding around or within the building.

Inherent benefits	**Inherent hazards**
Are normally located within the confines of a construction site with controlled access. Health and safety files should be readily available during working hours of the site.	Partial or structural collapse. Unexpected and rapid firespread, including undetected firespread and firespread breaching a compartment. External firespread – fire size could impact on adjacent buildings. Cable entanglement. Issues with access or egress.

Fire and rescue service considerations

- Incident commanders should avoid relying on experience from dealing with fires in completed structures and proceed with caution
- Consider that signage intended for the completed building (such as fire escapes) may be superseded by temporary site-specific signage
- Liaise with the Responsible Person, or appointed competent person, for up-to-date site risk information and the status of fire protection

- Consider the potential for rapid firespread throughout the incomplete building or structure due to lack of fire protection, and if it could affect access and egress routes
- Consider and identify if possible, how the integrity of the building may present significant hazards, for example falls from height due to unguarded openings in floors
- Consider the presence of temporary lighting which may present an entanglement hazard
- Consider the potential for firespread to adjacent buildings

References

Fire Prevention on Construction Sites 9th edition – Construction Industry Publications Ltd/Fire Protection Association, October 2015

16 steps to fire safety on timber frame construction sites. Structural Timber Association. 3rd Edition 2014.

Construction or demolition
Legislation
Description There is a legislative framework surrounding fire safety in buildings and also buildings under construction or demolition.

General considerations

In addition to legislation mentioned in the Fires in the built environment guidance and also health and safety legislation mentioned in Fires and firefighting guidance, fire safety in buildings under construction or demolition is regulated by Construction, Design and Management Regulations 2015.

Construction, Design and Management Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) came into force in Great Britain on 6 April 2015**.** The regulations set out what people involved in all commercial construction work need to do to protect themselves, and anyone the work affects, from harm.

CDM 2015 aims to improve health and safety in the industry by ensuring those involved in construction work:

- Sensibly plan the work so the risks involved are managed from start to finish
- Have the right people for the right job at the right time
- Co-operate and co-ordinate working with others
- Have the right information about the risks and how they are being managed
    - In England and Wales this includes carrying out a fire risk assessment under the Regulatory Reform (Fire Safety) Order 2005, for which the enforcing authority is the Health and Safety Executive
- Communicate this information effectively to those who need to know
- Consult and engage with workers about the risks and how they are being managed

Doors

Fire doors

Description

A door or shutter provided for the passage of persons, air or things which, together with its frame and furniture as installed within a building, is intended when closed to resist the passage of fire and/or gaseous components of combustion and is capable of achieving a specified level of performance to those ends.

General considerations

Fire doors are provided within strategic locations within a building (or as entry to additional areas of a building) where passage through a line of fire resisting construction is to be achieved. Such locations can include, surrounding the enclosure to a protected escape route, lobby or stair, within a line of compartmentation, or at the access to a protected shaft. The overall objective of the fire door is to maintain a level of fire resistance as required i.e. restrict the passage of smoke and flame within the building either for the protection of life or property.

Figure 3: Fire doors

It is important to understand that a fire door is defined by the performance of the door set as a whole. This includes the door leaf, door linings, all fixings and apertures. A fire door may also be designed to restrict the passage of smoke. All specified fire doors (except in single dwellings, houses) should be indicated by signage, for example Fire Door Keep Shut. They are designed to meet the requirements for a particular part of a building and may be fire rated as, for example, FD30 for a fire door of not less than 30 minutes fire resisting integrity or FD30S for the same fire door also designed to resist the passage of smoke at ambient temperatures.

There is a common misconception that the periods of fire resistance quoted for fire resisting elements (including doors) relate directly to the period of time for which they will resist the passage of fire and/or smoke during a real incident. Ratings for fire doors relate only to the severity of the furnace used to carry out the fire resistance test and provide only an indication of the fire resistance rating defined by a British Standard Fire Door Test. Fire door ratings provide guidance for the period of time the door has resisted fire and smoke in test conditions and are therefore only intended to provide a comparison between one product and another, not an absolute indication of performance in a real fire.

It should be noted that in the case of some the entrance doors to flats and some service risers or stairs the fire resistance of the fire door may only be half that of the line of compartmentation in which it is situated i.e. a 30 minute rated fire door in a 60 minute wall.

Fire doors can be constructed from many different materials including timber, steel and composite materials; all fire doors are engineered to achieve the rating to which they are designed and tested. Most timber fire doors only provide 30 to 60 minutes fire resistance.

Timber doors, when exposed to heating effects can shrink towards the fire, whereas steel doors distort away from the heat. Composite doors can distort in either direction, or not at all.

Timber fire doors should always be provided with intumescent seals around the intersection of the leaf and frame reveal as well as around glazed apertures or penetrations such as letter boxes, viewers and air transfer grilles. The purpose of the intumescent materials is to seal the edges of the door from flame and smoke and to protect the timber from erosion around ironmongery and to expand and fill any voids where flame and smoke can penetrate.

Inherent benefits	**Inherent hazards**
Correctly installed and maintained fire doors should help to contain a fire within a compartment.	Damage, patching, poor maintenance or poor workmanship with regard to fire doors may allow for the spread of smoke between compartments. External fire door exits may be difficult to access from the outside. A fire door may be held in place by the intumescent strips rather than ironmongery and will not open in the usual manner and may fall out of the aperture if dislodged.

Fire and rescue service considerations

- Where possible ensure smoke stop or fire doors remain closed
- Where possible ensure fire door integrity is maintained until firefighting media and resources are positioned, ready to commence firefighting operations
- Identify inappropriate alterations to external compartment doors, for example occupants of residential flats may change front doors for aesthetic purposes

References

Approved Document B

Association for Specialist Fire Protection (ASFP)

Doors

General purpose doors

Description

Doors which are not specified as fire resisting and act to subdivide areas of the building and control the physical atmosphere of a space.

General considerations

General purpose doors may come in the form of any of the following; hinged doors, swing doors, revolving doors, sliding doors and cantilever doors. They may be used in external or internal situations as entrance or exit doors to buildings, or as entrances to compartments within a building such as rooms or offices.

Figure 4: General purpose door

The most common door type found are hinged doors closing against a rebate on the door jam and can be in the form of single doors, which close against a door jamb or in pairs (double doors) which meet at a central point.

General purpose doors in the built environment may be constructed from steel, timber, PVC, plastic or composite materials which include a mixture of all three materials and may also be partly or fully glazed.

It is important to understand that not all doors within a building are fire resisting doors however general purpose doors may carry inherent fire resisting properties depending upon their construction, but cannot always be relied upon. Door leafs specified as fire resisting are often used within buildings due to their heavier construction, increased weight, robustness and apparent higher quality however this will also not present a fire door as the term fire door refers to the door set as a whole system (leaf, lining, aperture, fixings etc.).

General purpose doors are also designed to be easily operational during escape, particularly if they are installed across a means of escape route, but may be designed to hinder or prevent entry in the opposite direction. This may present hazards to firefighters who may generally wish to travel in the opposite direction, for example regarding the direction of door swing and location of latches and locks restricting access or egress.

Inherent benefits	Inherent hazards
A standard door will usually still serve to contain the spread of fire due to the inherent fire resisting properties of the materials in use but this cannot always be relied upon. It should also lessen the spread of toxic smoke and fumes into otherwise unaffected parts of the building for a short amount of time.	A standard door may become jammed, particularly under the effects of heat due to distortion. Standard doors are not designed to act as an insulator to heat nor have resistance to the passage of fire and smoke. Doors may also be blocked from fully opening if general housekeeping in the building is poor. A door may be incorrectly signed as a fire door.

Fire and rescue service considerations

- Anticipate early failure

• Where possible ensure door integrity is maintained until firefighting media and resources are positioned, ready to commence firefighting operations
References Approved Document B

Doors
Roller or sectional shutter doors
Description These are devices consisting of many horizontal slats hinged together which open and close vertically with the function of closing or protecting an opening in a wall or floor. The way in which they retract can be vertically or horizontally in a rolling or sectional manner.

General considerations

Shutter doors can be motorised or, for some smaller types, manually operated.

These may be constructed from timber or a composite material but more commonly are made of steel.

The most common use for shutter doors is as a security measure for commercial premises. But they may also be encountered in domestic premises.

Figure 5: Shutter door

Gearing mechanisms and fixings for roller shutters can be built-in or simply fixed to the external structure.

Both types of door can contain a wicket or personnel door which is a smaller pedestrian access hinged door built into the larger shutter door. There are varying types of wicket door installations and some can be installed as a re-fit to roller shutter doors and may render the roller shutter unusable. Wicket doors may not affect the operation of sectional shutter doors.

Some roller shutters are fire resisting; these shutters are designed to close upon activation of the detection of fire within the vicinity of the shutter, either by a thermally activated device or through appropriate interfacing of the automatic fire detection system. If the shutter is located across a means of escape then it should not close automatically or only partially close for smoke control purposes.

It is common that the fire resisting shutters do not provide any insulation properties.

Inherent benefits	**Inherent hazards**
Roller shutters should be capable of being opened manually without the need for a ladder.	Shutter doors may cause difficulty with access to a building. A shutter door may become jammed, particularly under the effects of heat and especially if the fixings or mechanisms are exposed. These may have a wicket door installed which may prevent the shutter from opening fully.

Fire and rescue service considerations

- Consider using alternative points of access
- Ensure opened roller shutters are secured to maintain access and egress
- Roller shutter doors may be cut to gain access but care should be taken as some shutters may retract

abruptly once completely severed

- Consider failure of fixings leading to potential collapse of unit
- Clear severed sections from the access and egress point to reduce potential trip hazards

References

Approved Document B

Doors
Security doors
Description Doors which are used to restrict or control the access of individuals within a building.

General considerations	
Security doors are generally of a robust nature and are likely to be constructed from steel or composite materials. However security doors are increasingly being installed at domestic properties as front entrance doors.	
Inherent benefits	**Inherent hazards** Access and egress may be restricted and require the assistance or co-operation of authorised staff. Security doors may be designed to self-lock upon closing. Security doors constructed with bars may pose restrictions to access. They will also have little inherent benefits with regard to prevention of smoke and flame spread inherent in solid doors.
Fire and rescue service considerations • Liaise with the Responsible Person, or appointed competent person, to identify types and locations of security doors, provide assistance • Familiarisation with the various types of security doors • Maintain access once opened by securing door in open position, positioning personnel or site staff to ensure access egress is maintained • Consider using alternative points of access	
References Generic risk assessment 3.9: fighting fires in places of lawful detention DCOL 38/1978	

Envelope – fabric
Roofs
Description A roof is a covering to a building to provide protection from one or all of rain, wind, heat and sunlight

General considerations

A roof structure can come in a range of shapes and sizes. Each however could be generally termed pitched (inclined), flat or curved. Materials used in roof construction can include timber, steel and sometimes concrete.

Specific roof design types which are common include;

Trussed roof – A roof designed using a collection of members and connections that work as a system under a combination of tension and compression.

Pitched roof – Often very similar in appearance to that of a trussed roof within domestic examples, however often constructed from traditional cut timber.

Mansard roof – A split pitched roof often indicating a habitable space within the roof,

Monitor roof – These are often of lightweight construction and for the purpose of providing means of additional light to the building through the installation of glazed upstands.

Flat roof – This may be as simple as a weatherproofed floor system including steel or timber joists

Roof spaces are not generally designed for people, however as mentioned above certain characteristics can indicate a habitable space such as a mansard roof, rooflights within a pitched, trussed roof or dormer windows. Such features can act as means of access and egress for the fire and rescue service as well as a means of ventilation for the fire.

Figure 6: Roof structure

Large cavities are often created within habitable roof spaces between the ceiling and wall construction and the ridge and wall plates respectively. In the case of uninhabited roofs, small hatches often provide the internal access for the roof space which are also not generally provided with a full floor system.

As roofs are designed to protect from the elements of weather they also present difficulties in fighting fire from the outside.

As a roof is not classed as an element of structure the fire safety requirements for roofs are far less than for habitable storeys. The materials and cavities within roof spaces can cause fire to spread rapidly and extensively through roof voids.

A lack of compartmentation between properties (e.g. terraces) can also allow for extensive spread of fire to neighbouring residencies.

Inherent benefits	**Inherent hazards**
	A roof is not a structural element of construction so

Roof types are easy to identify Roof lights can provide ventilation points.	may therefore collapse during the early stages of a fire, especially if the fire is in the top storey of a building. Roofs may contain within the construction or be covered with flammable materials. Common roof voids within terraced buildings can cause firespread to neighbouring residencies. Firefighters should be aware temporary and loose flooring within the roof space Limited access for firefighters Less ventilation Asbestos cement which may often be present in flat roof construction can give way easily.

Fire and rescue service considerations

- Consider potential for collapse in early stages of a fire
- External firefighting is of limited use due to roof construction, therefore internal firefighting should be considered and risk assessed
- Investigate adjoining roofs for potential undetected firespread
- Consider the presence of decorative features such as false chimneys and any effect they may have on the potential for failure in a fire
- Consider the need for working at height procedures or aerial appliances
- Consider the need for creating external access to scene of fire
- Consider use of thermal image camera

References

Generic risk assessment 3.1: fighting fires in buildings

Envelope – insulation
Air filled cavities
Description Air filled cavities within the external envelope of the building used for insulation.

General considerations

Concealed spaces or cavities within the construction of a building provide a ready route for flame and smoke spread. This is particularly so in the case of voids located around the envelope of the building required for insulation.

These cavities are likely to exist between the masonry and/or concrete inner and outer leaf of the external wall, or behind the external skin of an external cladding system.

In essence, to reduce the potential for unseen spread of fire and smoke within cavities, cavity barriers should be provided to sub-divide the cavity at strategic locations, such as:

- At the junction with another cavity
- Around openings
- In line with internal compartmentation
- At set distances, maximum every 20m

Combustible materials within the air filled cavity may provide additional means of smoke and firespread. These combustible materials may be in the form of combustible insulation or ignition sources which may have entered the cavity, for example through the air bricks provided within the external finish of the building.

Figure 7: Combustible insulation

Secondary ignition within a cavity after the fire has been attended should also be taken into consideration due to any unseen effects which may be continuing within the cavity after all the visible effects of the fire have been addressed.

Inherent benefits	**Inherent hazards**
Issuing smoke from cavities can inform as to fire progress. The use of heat detection cameras can also inform as to the extent of unseen fire and smoke spread within the cavity.	Air and fuel available for the fire and smoke to spread. Issuing smoke can be misleading as smoke may have spread away from the seat of the fire within the cavity. Combustible materials within air-filled cavities can allow the fire to propagate. It is difficult to find a fire located within a cavity. Potential for cavity fire to be attacking elements of structure that are built into the cavity.

	Fires within a cavity may damage the tying mechanism between the levels of a cavity increasing the risk of collapse. Poor workmanship associated with the installation of cavity barriers can lead to large cavities being created breaching several different lines of compartmentation in a building.

Fire and rescue service considerations

- Investigate any sources of smoke from ventilation bricks, soffits or any other unusual location
- Consider the use of thermal imaging cameras
- Observe for signs of structural failure which may lead to collapse
- Initiate a thorough post fire investigation to identify potential breaches to cavities or adjoining cavities, extensive cutting away maybe required

References

Envelope - insulation

Combustible insulation

Description

Combustible materials used within cavities around the external envelope of the building for insulation.

General considerations

Insulation material may be present within cavities formed by the inner and outer leaf of the external wall of the building, depending upon the material used the insulation material may be combustible.

Combustible insulation should not be used in the cavities within buildings that are over 18m in height.

Combustible materials may contribute to fire growth and spread within the cavities which may result in the unseen spread of fire and smoke.

Combustible insulation may also melt in a fire scenario and create a cavity which was not there in the first place. In this instance there is the possibility that the provision for cavity barriers within this area has not been made, therefore allowing for further firespread which may go unseen.

Increased levels of insulation within buildings are potentially leading to more severe fire scenarios, i.e. heating up the room to higher temperatures during fire growth. This may have the effect of accelerating the onset of flashover.

Highly insulated buildings may make thermal imaging cameras less effective .

Inherent benefits	Inherent hazards
Issuing smoke can inform fire progress	Air and fuel available for the fire and smoke to spread Fire may burn undetected some time Unpredictable firespread smoke travel may occur resulting in misleading information with regard the location of the seat of the fire Higher temperatures may result in earlier rapid fire development Combustible materials within air-filled cavities can allow the fire to propagate.

Fire and rescue service considerations

- Identify cavities within buildings and type of insulation used
- Cut away to expose cavity and inspect area thoroughly if combustible insulation has been affected by fire
- Consider the effects of ventilation flow path when cutting away or exposing cavity
- Consider the use of thermal imaging cameras

References

Envelope - insulation
Non-combustible insulation
Description Non-combustible insulation materials used within cavities around the external envelope of the building for insulation.

General considerations	
Insulation material may be present within cavities formed by the inner and outer leaf of the external wall of the building, depending upon the material used the insulation material may be non-combustible. Non-combustible insulation should be used in the cavities within buildings that are over 18m in height unless testing has been carried out that has demonstrated the appropriateness of an alternative system. Non-combustible insulation may also form part of a wall designed to provide some period of fire resistance. Non-Combustible materials should not contribute to fire growth and spread within the cavities. Where the cavity is entirely filled with non-combustible insulation, fire and smoke spread should be restricted by the non-combustible insulation. Non-combustible materials are likely to maintain Increased levels of insulation within buildings during a fire potentially leading to more severe fire scenarios i.e. heating up the room to higher temperatures during fire growth. This may have the effect of accelerating the onset of flashover. Highly insulated buildings also make thermal imaging cameras harder to use.	
Inherent benefits Firespread should be limited where non-combustible materials are present.	**Inherent hazards**
Fire and rescue service considerations	
References	

Fabric - external wall finish - cladding

Cladding

Description

External cladding is, commonly, a non-structural material or assembly that is used to cover structural surfaces on the outside of the building for aesthetic reasons, insulation or to provide protection from weather and climate.

Figure 8: External cladding

General considerations

Cladding may be combustible or non-combustible depending on the material used. The following materials are typically used to provide external cladding applied to the face of building envelopes:

- Clay – Used in panel systems as small standard-sized components, such as tiles and terracotta slip systems.
- Concrete – Pre-cast concrete panels as slabs applied to a solid background or as cladding to a structural frame, independent of any in-fill walling.
- Thin stone – Can be used with or without insulation as a natural veneer or epoxy-bonded to honeycomb backing panels.
- Metal – Steel, stainless steel, copper, bronze and aluminium are generally used in sheet form for cladding to walls as:
  - Profiled metal sheeting
  - Metal panelling
  - Aluminium and steel profiled cladding

Figure 9: External cladding

- Brickwork – Used in a wide range of applications and is a suitable cladding for other materials such as concrete.
- Glazing – Found as a component in the majority of facades in a variety of forms, such as in-fill panels, windows, and suspended glazing. Single, double or fire-resisting glazing may be used.
- Render – Typically a thin layer of cementitious render applied to a rigid insulation board substrate.

As the technology has developed in this area, hybrid systems are increasingly being offered to the market that use a combination of materials, such as thin stone veneers resin-bonded to insulated carrier substrates, polymer resin-bonded boards, and pre-insulated panels. Often several of these finishes will be applied in combination to a single building.

Cladding systems may also require an insulation material which is typically fixed to the supporting structure using a combination of mechanical fixings (both plastics and steel), adhesives and in some cases railing systems on uneven surfaces. For general refurbishment or masonry-based systems a single product is typically applied to the supporting structure, using a combination of mechanical and/or adhesive-based systems. On uneven or lightweight frame systems that require a cavity between the insulation layer and the sheathing boards, railing systems are typically applied.

Insulating materials typically used in external cladding systems fall into the following groups:

- **Non-combustible materials and materials of limited combustibility** (as defined in Tables A6 and A7 of Approved Document B). Generally mineral-fibre-based products such rock fibre and glass wool which are formed into batts, typically 600 mm × 1200 mm or on continuous rolls, typically using resin binders. The thickness of these products can vary significantly depending upon the thermal performance specification.
- **Thermosetting** – Products such as polyurethane foam (PUR), polyisocyanurate foam (PIR) and phenolic foam are used to provide insulation for external cladding systems and are typically provided as 600 mm × 1200 mm sheet product of varying thicknesses to meet thermal performance requirements. These products are often faced with materials such as glass fibre or aluminium foil.
- **Thermoplastic** – Expanded polystyrene (EPS) is the most widely used product in this group, which also includes extruded polystyrene (XPS). It can be supplied in both a fire-retarded and non-fire-retarded form. Again the material is generally supplied as 600 mm × 1200 mm batts at various thicknesses to meet thermal performance requirements. If exposed to fire these types of insulation will soften and melt which can create a void providing a route for firespread.
- **Natural fibres** – Examples such as wood fibre, cork, sheep wool, cellulose and hemp are becoming increasingly widespread. The products are generally soaked, heated and compressed to produce the board product. In some cases binders are also used to provide the required performance characteristics. The material is generally supplied in sheet form at various sizes and thicknesses to meet thermal performance requirements. These products may also be available as in situ fill products that are 'blown' into voids on site.
- **Recycled materials** – A wide range of recycled materials, such as recycled paper and newsprint, shredded rubber and combinations of other materials, are available as insulation products, which may be treated or used with binders to achieve the required application and performance characteristics. The form that these recycled products takes can vary from compressed boards to blown infills.

The fire performance of minor items such as breather membranes, vapour barriers and gaskets also needs to be considered; in isolation they may not pose a fire risk, but when used over large surface areas in multi-storey dwellings they have the potential to contribute to firespread on or through the system by offering a route to bypass fire prevention measures such as fire breaks and cavity closers.

There are two types of cladding system used:

- **Non-ventilated** – Typically used for refurbishment on masonry-based substrates where a continuous background structure, such as an external wall is being upgraded. The system is typically composed of two elements: The insulating material is typically fixed to the masonry background structure, to provide the necessary level of thermal performance. The external surface finish generally provides the weather protection to the insulating layer. Heat from a fire may weaken mortar and therefore make stone and brick slip cladding likely to fall.

- **Ventilated** – These systems typically consist of an inner structural leaf that is insulated on its outer face, and are finished with an external surface membrane or cladding assembly. Generally, the insulation layer is fixed to either the inner structural leaf or the cladding panel, together with an appropriate breather membrane. These systems inherently produce cavities between the cladding and the surface beneath, which may allow for unseen firespread if adequate cavity barriers are not employed as recommended in Approved Document B. If a fire in such a cavity attacks the connections between the cladding and the surface beneath then this may cause the cladding to fall with little or no warning.

Figure 10: Non-ventilated cladding

Figure 11: Ventilated cladding

For frame-based wall systems (from internal room face to external weather face) the stability of the overall system is based on the wall frame's ability to remain in place during a fire. Any deformation or degradation of the framed wall may have a detrimental effect on the fire performance of the external cladding system.

Falling combustible cladding may cause firespread to floors below the original or primary seat of fire. Cladding which has plastic or aluminium components may also produce molten droplets when exposed to fire which may drip onto people or objects below.

The failure of cladding may leave the underlying structure of the building exposed. This may aid firefighters in the identification of the structural elements and materials used within the building but may also leave the structure more exposed to the fire.

Inherent benefits	Inherent hazards
	The potential for external firespread with combustible cladding systems. Hidden firespread behind cladding. This can lead to a second seat of fire if the fire spreads up a cavity and breaks out higher up the structure. Falling debris may present a hazard to people outside of the building or cause downward firespread. It may be difficult to identify the structural elements and materials of the building if they are hidden behind cladding and the cladding itself may also be difficult to identify (e.g. brick slips vs. load-bearing brick wall). There is potential for sheets of glazing or aluminium to become detached from the building and glide or "plane" due to their shape and can travel some distance from the property.

Fire and rescue service considerations
• Consider potential for undetected firespread • Consider the use of thermal imaging cameras • Consider potential failure of fixings • Consider appropriate cordon distances due falling debris traveling a considerable distance from the building
References
Colwell, S and Baker, T. (2013) Fire performance of external thermal insulation for walls of multi-storey buildings: (BR 135) Third edition. BRE Press. Approved Document B

Fabric - external wall finish - cladding
Glazing
Description Glazing used as a non-load bearing wall. See also windows: glazing and structural material: glass

General considerations

Glazing is used to provide light within a building. In many buildings (common with retail premises) the glazing on the external façade is purely provided as an architectural feature. A false wall is commonly provided behind the glass façade to prevent daylight penetrating the building.

Glazing may be provided to provide an infill wall between two floors, or may be provided as curtain walls which may be some distance away from the floor slab, such that there is a gap up the inside of the external wall. Glazing will normally undergo rapid failure when affected by fire but undamaged glazing may be difficult for firefighters to break.

On the external façade of a building the glass may be offset from the "true" external envelope of the building to provide a solar shade.

Figure 12: External glazing

Inherent benefits	**Inherent hazards**
Firefighters may be able to see through glazing to the inside of the building.	Glazing does not have to be directly involved in a fire for the fire to spread through it by radiant heat. Glazing can fall out, crack or shatter, particularly as a result of thermal shock (e.g. sudden cooling from firefighters' hose jets). Falling or planing glass traveling considerable distances from building Failure of external glass walls may leave personnel exposed to the risk of falls from height

Fire and rescue service considerations

- Consider that glass sections may travel considerable distance from building when establishing cordons
- Identify alternative access routes to avoid areas of glazing affected by heat
- Consider working at height procedures when working internal near to where glazing has failed.
- Avoid pitching ladders on external glazing, consider Ariel Ladder Platforms (ALP)

References

Fabric - external wall finish - cladding
Sandwich panels
Description Sandwich panels used as cladding to the external envelope of the building. Refer to Internal fabric: sandwich panels

General considerations

Insulating core panel systems are used for external cladding as well as for internal structures.

Sandwich panels consist of an insulating material between two metal (usually steel) faces which provide rigidity and robustness to the panel. The insulating material may be combustible or non-combustible. They are used to provide protection from weather and climate.

The combustible nature of the sandwich panel core is likely to be difficult to identify without intrusive inspection. However the behaviour of the insulating material may have a significant impact upon fire development. Sandwich panels may de-laminate at high temperatures consistent with compartment fires. This may result in the insulating core material becoming exposed to fire.

Non-combustible materials and materials of limited combustibility (as defined in Tables A6 and A7 of Approved Document B). Generally mineral-fibre-based products such as rock fibre and glass wool which are formed into batts, typically 600 mm × 1200 mm or on continuous rolls, typically using resin binders. The thickness of these products can vary significantly depending upon the thermal performance specification. These types of panels may remain in place for some time, even after delamination of the steel face due to heat, and therefore contain the heat of the fire and contribute to severity of conditions inside the building.

Combustible materials

Combustible materials within sandwich panels will generally include expanded polystyrene (EPS) and extruded polystyrene (XPS). If delamination of these panels occurs, then this may lead to concealed firespread within the sandwich panels and rapid firespread throughout the building. Paint charring on the surface of a panel may indicate the extent of firespread within the panel.

Damaged panels may produce falling debris and molten droplets, and if this consists of combustible materials then it may also cause downward firespread. However, failure of these panels may also lead to venting of the fire, releasing heat and smoke in the building.

Damage to panels from fire or otherwise may provide an indication to firefighters of the type of insulation used in their construction and therefore allow for an assessment of the risks associated with the particular type of panel. However, it is important to consider that a single building may feature more than one type of sandwich panel.

Inherent benefits	**Inherent hazards**
	The potential for external firespread with combustible sandwich panel cladding systems. There is potential for rapid firespread within the panel. A melting EPS, XPS core may cause a burning liquid fire. Combustible sandwich panels may cause dense corrosive and toxic smoke. Falling debris may present a hazard to people outside of the building or cause downward firespread. It may be difficult to identify the structural elements and materials of the building if they are hidden behind cladding.

Fire and rescue service considerations

- Investigate for potential undetected firespread leading to rapid failure and collapse
- Investigate for firespread into building through openings in walls and roofs

References

Approved Document B

Shipp, M. Combustible sandwich panels

Sun Valley Limited (Hereford and Worcester Fire and Rescue Service, 1993)

Atherstone on Stour (Warwickshire Fire and Rescue Service, 2007)

Facilities for firefighters
Fire control rooms
Description A fire control room is a room provided in large buildings, complex buildings, or buildings that incorporate phased evacuation. The room is intended to support firefighting operations.

General considerations

A fire control room should be provided in all buildings designed for phased evacuation, and in large buildings or complex buildings.

The fire control room should be either:

a) a room dedicated solely as a fire control room; or

b) combined with the management central control room.

The fire control room should be adjacent to a fire service access point and should be readily accessible, preferably directly from the open air. If this is not practicable, the route to the fire control room should be protected. Because of the possible need for the fire control room to be operational over an extended period of time, it should be separated from the remainder of the building by 2 hour fire-resisting construction and should incorporate facilities to enable it to function as normal during an emergency.

Throughout the building, a reliable means of firefighter communication may be installed and, where provided, should be connected with the fire control room.

The fire control room should normally contain:

- All control and indicating equipment for the fire alarm and other fire safety systems for the building;
- Indicator panels showing the location of the incident and status of all automatic fire protection installations and facilities;
- Manual override switches associated with all automatic fire protection installations and facilities
- Manual overrides for air-conditioning systems or ventilation systems involving recirculation;
- A communication system providing a direct link between the control room and all firefighting lobbies;
- An exchange telephone with direct dialling for external calls;
- A public address system;
- Controls and monitor screens for closed circuit television (CCTV) if it is provided for the control of evacuation;
- The fire routine for the building;
- Keys or other devices needed to facilitate access throughout the building and to operate any mechanical and electrical systems;
- Floor plans of the building;
- Telephone numbers of principal staff and building services engineers;
- A facility to sound the evacuation signal in each evacuation zone by individual switches or throughout

the building by means of a single switch. The single switch for total evacuation should be protected against accidental operation and from being inadvertently left on when the building is fully occupied. (Such a switch should not be used to signal the evacuation of the building when fully occupied where stairs have been provided to cope only with phased evacuation, as the stairs will be too narrow);

- A facility to sound the alert signal throughout the building;
- A clock to time phases of evacuation;
- A visual indication in the control panel relating to the status of relevant parts of the building where an evacuation signal has been given;
- A facility to cancel any automatic sequencing of phases of the evacuation procedure except for the initial phase;
- A wall-mounted writing board with suitable writing implements for displaying important information.
- Competent persons should be assigned to the control room and familiar with its interaction with all of the building systems so that they can assist with controlling these systems as needed by firefighting personnel.

Inherent benefits	**Inherent hazards**
Provide a safe haven to conduct firefighting operations within the building. Enable firefighting management systems to co-ordinate activities within the building.	Potential for unintended consequences occurring as a result of operation by personnel unfamiliar with the systems in place.

Fire and rescue service considerations

- Establish communications between control rooms and operational areas
- Liaise with the Responsible Person who will ensure only a competent person operates any integrated system
- Deploy dedicated team to control room

References

Digital Equipment Limited (Hampshire Fire and Rescue Service, 1990)

Facilities for firefighters

Fire mains

Description

Fire mains are provided in buildings to ensure firefighting water supplies can be provided from the outside of the building to various strategic locations within the building.

General considerations

Fire mains enable firefighting water to be circulated around tall buildings, complex buildings or buildings incorporating deep basements. Depending upon the size and complexity of a building the fire mains may provide slightly different facilities although the function is the same.

Fire mains are commonly associated with a firefighting shaft.

Figure 13: Fire mains outlet

All fire mains have common components:

- Inlet valve – commonly located on the outside of the building, within 18m of the firefighting access, enabling connection of the firefighting media to supply the fire mains
- Landing valve – commonly located within the firefighting lobby of the firefighting shaft enabling the connection of the firefighting media to facilitate firefighting activities.
- Supply pipe – pipe that connects inlet valve and landing valve.

Figure 14: Dry riser

Within tall buildings, up to 50m high, most complex buildings and buildings incorporating deep basements the fire mains will be in the form of a dry riser (or dry falling main with respect to basements). A dry riser and dry falling main require water supplies from the attending fire authority.

For tall buildings over 50m tall and some complex buildings a wet riser will be provided. A wet riser is provided as additional pumping capacity, greater than the capabilities of a firefighting appliance, is required to overcome the pressure losses and mechanical forces required to move water to very high (or long) distances. Wet riser systems will incorporate water supplies (similar to sprinkler systems) but may require replenishment through a dedicated inlet valve.

Figure 15: Dry riser landing valve

Inherent benefits	**Inherent hazards**
Enables firefighting water to be circulated around a building Reduces equipment to be carried around a building.	Unavailability of fire main due to poor maintenance and lack of security Possibility of over running water supply

Fire and rescue service considerations

- Set into main and charge on the instruction of incident commander
- Consider implementing temporary main
- Suitable breaking in gear for accessing fire main
- Ensure landing valves are closed
- Consider early provision of adequate water supply (e.g. consider request of water pressure increase)
- Efficient use of firefighting water
- Identify appropriate inlet and outlet. In complex buildings, this may not be immediately apparent
- Wet risers may require supplementing by fire and rescue service

References

Facilities for firefighters
Fixed communication systems
Description Fixed firefighter communication systems are normally provided in large or complex buildings and underground structures. They are provided to support firefighter communications where standard radios may be compromised.

General considerations

In large or complex buildings there needs to be a reliable means of communicating from the fire service access level to all firefighting lobbies (and the lift machinery space or panel where provision is made to recover a stalled lift car).

Fire Service mobile communications should preferably be supplemented by some form of fixed communications system, for example, a fire telephone system or a fire and rescue service compatible leaky feeder radio signal booster system.

Where fire telephone handsets are provided they should be located at strategic points, for example, at each building entrance, in firefighting lobbies and in the fire control room and should be permanently fixed equipment.

Firefighters will normally use personal radio sets for communicating with each other and with their own command points. However, personal radio sets have disadvantages such as occasional poor reception due to local screening and limited battery life.

Fire and rescue service compatible leaky feeders are communication systems normally consisting of a coaxial cable run along tunnels, or complex and large buildings, which emits and receives radio waves, functioning as an extended antenna. The cable is "leaky" in that it has gaps or slots in its outer conductor to allow the radio signal to leak into or out of the cable along its entire length.

The signal is usually picked up by portable transceivers carried by personnel. Transmissions from the transceivers are picked up by the feeder and carried to other parts of the underground structure or building, allowing two-way radio communication throughout.

The system has a limited range and because of the frequency it uses (typically VHF or UHF), transmissions cannot pass through solid rock, for example, which limits the system to a line-of-sight application. It does, however, allow two-way mobile communication.

This system is also used for underground mobile communication in mass transit railways. In London, London Underground uses a leaky feeder system for their internal communication network Connect.

Inherent benefits	**Inherent hazards**
Firefighting communications systems will enable enhanced communication with firefighter command operations throughout the building.	In some buildings fixed firefighter communication systems may be used for Emergency Voice Communication systems associated with disabled refuges. Incident commanders taking control of the fire communication systems must be aware of non-firefighters using the same systems.

Fire and rescue service considerations
• Use internal communications as an additional to fireground communication not as an alternative • Consideration should be given to communication systems having a dual use, e.g. those provided for refuges • Take control of fixed communications • Caution must be exercised when using fixed communications systems as non-fire service personnel may also use these systems • Confidential information must not be broadcast using these systems e.g. fatalities located
References

Facilities for firefighters
Hose reels
Description Hose reels are a fixed first aid firefighting media predominantly provided in various commercial buildings.

General considerations	
Hose reels are a fixed firefighting media designed for undertaking first aid firefighting intervention. They were originally provided for the use of attending firefighters and building occupants. Hose reels are provided and maintained by the building owner.	
Inherent benefits	**Inherent hazards** Hose reels will not provide sufficient flow or pressure to deal with a well-developed compartment fire
Fire and rescue service considerations • Consider hose reels as first aid firefighting only • Always use fire and rescue service equipment to deal with compartment fires	
References	

Facilities for firefighters
Fire hydrants
Description Fire hydrants are an interface connection for firefighters to access the local water main supply.

General considerations

The majority of buildings should be located within 100m of a hydrant.

The pressure and flow of water available at a hydrant is maintained by the local water authority.

Inherent benefits	**Inherent hazards**
Provide water supply for firefighting operations.	Pressure and flow at hydrant may be less than required for effective firefighting. In some areas a significant number of buildings will be located further than 100m from a hydrant.

Fire and rescue service considerations

- Identify location(s) of suitable hydrants (vicinity and size of main)
- Consider additional resource requirements in areas of poor water supplies or pressure
- Consider use of alternative firefighting media in areas of poor supplies, for example compressed air foam (CAF) or abrasive water jet cutting
- Avoid using multiple hydrants off the same main
- Awareness of district metered areas (DMA)
- If pressure is insufficient liaise with local water provider to increase localised pressure
- At large incidents high volume pump (HVP) may provide secondary main from an alternative water source
- At large incidents consider taking water supplies from separate mains
- Consider effects of water usage on residential areas, medical services and industrial processes (such as dialysis and cooling)

References

Facilities for firefighters
Firefighting lift
Description A firefighting lift is a lift that is often provided within a tall building, complex building or a building with deep basements. The purpose of a firefighting lift is to provide a facility to assist firefighters to move with more ease vertically through a building.

General considerations

A firefighting lift installation includes the lift car itself, the lift well and the lift machinery space, together with the lift control system and the lift communications system.

Figure 16: Firefighting lift and controls

A firefighting lift, unlike a normal passenger lift, is designed to operate so long as is practicable when there is a fire in parts of the building beyond the confines of the firefighting shaft, as it is used to transport firefighters and their equipment to a floor of their choice.

The lift can be used in normal times as a passenger lift by the occupants of the building but, in order to prevent the risk of the entrance being obstructed when the lift is required to go into the firefighting mode, it should not be used for moving refuse, nor for moving goods. In buildings provided with a single lift its use for the transport of goods should be avoided unless essential, lift lobbies should be kept clear, and when used for moving goods the doors should not be propped open to ensure that the lift remains at a particular level.

Firefighting lift cars should be provided with a means of external rescue of trapped firefighters in the lift car.

There have been several recorded occasions when water from a landing valve, hose lines, etc., has entered the lift well and caused malfunction of the installation when it reached electrical door interlocks, car controls, etc. It is therefore necessary to minimise both the effects of water on lift operations, and the probability of water entering the lift well in the first place.

A firefighting lift switch should be provided to enable the fire service to obtain immediate control of the firefighting lift(s) in a firefighting shaft.

The car controls of the firefighting lift should become active only after it has arrived at the fire service access level and the firefighting lift switch has been operated. Once the firefighting lift has arrived at the fire service access level, its doors should open and it should then operate as follows.

- Fire personnel entering the lift car should be able to register a call to any selected landing in the building by sustained pressure on a car control until the car doors have fully closed
- If a car control is released before the doors have fully closed, the doors should immediately reopen and the call should be cancelled
- Once the lift is moving, it should be possible to register additional calls on the car controls. The lift should travel in the direction of the first call registered, and should stop at the first floor encountered

for which a call is registered

- The doors should remain closed unless they are operated by continuous pressure on the “door open” control. It should not be possible to open the doors without sustained pressure on the control
- Release of the “door open” control before the doors are fully open should cause the doors to automatically re-close. This allows fire service personnel to observe the situation immediately outside the lift landing doors in the firefighting lobby
- Once the doors are fully open they should remain open until a new call is registered at the car control station

Inherent benefits	**Inherent hazards**
Assist in the vertical transportation of firefighters and equipment within a building.	Possibility of personnel becoming trapped Lift movement may increase ventilation to fire Firefighting lifts should not be used as service lifts however can be used by people Older “fireman’s” lifts may not have all the functionality/features of more recent firefighting lifts Not always readily identifiable Firefighting lifts may be used as part of the evacuation strategy

Fire and rescue service considerations

- Consider the impact of using firefighting lifts on the evacuation strategy
- Site specific information visits to identify locations and type of firefighting lifts
- Establish and maintain control of firefighting lifts during incidents
- Ensure the firefighting lift is not taken beyond the bridgehead or forward control point floor

References

BS EN 81-72:2003 – Safety rules for the construction and installation of lifts. Particular applications for passenger and goods passenger lifts. Firefighters lifts.

Facilities for firefighters
Firefighting lobbies
Description Firefighting lobbies are provided within firefighting shafts to assist attending firefighters in their operational duties

General consideration	
Firefighting lobbies are spaces in buildings which are enclosed in fire resisting construction. They normally separate horizontal and vertical circulation spaces (e.g. corridor and stairs or lifts) and/or separate circulation spaces from accommodation spaces (e.g. between flats and corridors). Their presence at these points should provide two lines of compartmentation (walls and fire doors) between the spaces they separate. The firefighting lobby at fire service access level should be large enough to act as a command post or control centre that could be used by the fire service. A firefighting lobby should be of sufficient size enable the fire service to lay out firefighting hose and connect it to the outlet from the fire main (if provided) without undue congestion. A firefighting lobby should be clearly and conspicuously marked. Firefighting lobbies may not be present within blocks of flats which have otherwise been designed to meet Building Regulation guidance (Approved Document B) with regards to means of escape and compartmentation.	
Inherent benefits Firefighting lobbies should offer a greater period of fire resistance and a protected space for firefighting activities during fire.	**Inherent hazards** Firefighting lobbies may become used for storage.
Fire and rescue service considerations • Consider the effect of hose lines compromising lobby area compartmentation, resulting in smoke spread into shaft	
References Approved Document B Generic risk assessment 3.2: fighting fires in high rise buildings	

Facilities for firefighters
Firefighting shaft
Description A firefighting shaft is a protected enclosure provided for attending firefighters containing a firefighting stair and firefighting lobby. If a lift is provided, this may or may not be a firefighting lift. These features are provided to assist attending firefighters in their operational duties.

General considerations

Firefighters need to be able to reach a fire quickly, with their equipment, to assist the fire service in protecting life, protecting firefighters, reducing building losses, salvaging property and goods and minimising environmental damage.

Firefighting shafts are likely to be provided in tall buildings, buildings with deep basements, and buildings with large floor areas. In general terms buildings with a floor at more than 18m (or 7.5m in buildings used as shops, factories and storage) above the fire and rescue service vehicle access level, or with a basement at more than 10m below fire and rescue vehicle access level should be provided with firefighting shafts. Some buildings, with storey heights between 11m and 18m, may be served by an escape stair fitted with a fire main.

A firefighting shaft is commonly provided with means of ventilating the firefighting lobby and firefighting stair.

In large complexes with a variety of uses, firefighting shafts may serve separate parts of the complex. For example, in a complex consisting of high-rise offices over a shopping centre, the offices may be provided with a dedicated firefighting shaft that does not serve the shopping centre.

Firefighting shafts should be located such that they allow access to every part of every storey that they serve and should wherever possible be sited against an exterior wall. If this is not possible the route from the fire service entrance to the firefighting shaft should be as short as possible and should be protected by fire resisting construction, commonly a fire resistance period of not less than 120 minutes, to ensure that fire does not affect the route or cut off the means of escape for the fire and rescue service or other personnel within the building.

The firefighting lobby at fire service access level should be large enough to act as a command post or control centre that could be used by the fire and rescue service.

A firefighting shaft incorporating a firefighting lobby at each level approached via a firefighting stair, and where provided with a firefighting lift should provide:

- Means of final approach to the fire floor;
- Floor-to-floor movement during firefighting operations;
- An assured and safe route of egress (generally provided by the stairs serving every storey served by the firefighting lift);
- A safe area on a floor below the fire floor, where firefighters and firefighting equipment can be assembled before commitment to firefighting operations.

A firefighting lobby should be of sufficient size to enable the fire service to lay out firefighting hose and connect it to the outlet from the fire main, if provided, without undue congestion.

A firefighting lobby should be clearly and conspicuously marked, although this is not always the case in residential premises.

Inherent benefits	**Inherent hazards**
Pre planning visits will yield the greatest benefit to be gained from firefighting shafts. Firefighting shafts offer a greater period of fire resistance. The housekeeping and maintenance within the firefighting shaft may provide an indication of fire safety compliance.	Firefighting shafts may commonly be used as an emergency escape where evacuating occupants may cause an obstruction

Fire and rescue service considerations

- Identify firefighting shafts as a primary means of access for firefighting where possible
- Identify facilities for firefighters, e.g. fire mains and fire lifts
- Consider the use of firefighting shafts for staging internal operational activity
- A firefighting shaft should be kept clear of obstructions and smoke, as this is the primary means of egress for firefighters in an emergency
- Hose lines may compromise smoke lobbies and firefighting shaft
- Take control of smoke control or ventilation systems

References

Approved Document B

Generic risk assessment 3.2: fighting fires in high rise buildings

Facilities for firefighters
Vehicle access
Description Vehicle access to the exterior of a building is required to enable high reach appliances such as turntable ladders and hydraulic platforms to be used and to enable pumping appliances to supply water and equipment for firefighting and search rescue activities.

General considerations

Vehicle access requirements increase with both building footprint and height.

Access for a vehicle and pump appliance for small buildings (those of up to 2000m^2 with a top storey of up to 11m above ground level) should be to at least 15% of the perimeter of the building or within 45m of every point of the footprint of the building and should increase with the size of the building.

If a fire mains inlet valve is available at the building, vehicle access should commonly be provided within 18m of the fire mains inlet.

Turning facilities should be provided in any dead end access route which is more than 20m long and may be in the form of a hammerhead or turning circle.

Inherent benefits	**Inherent hazards**
Should provide a suitable area for firefighting operations to commence outside of the building.	Remote locations may cause extended distances from the firefighting appliance to the scene of operations Extended distance from scene of operations to water supplies. Difficult terrain may impede vehicle access.

Fire and rescue service considerations

- Maintain access and egress of vehicle access routes around building where possible
- Anticipate access to route not being available due to parked vehicles and other obstructions
- Consider additional resources requirements in areas of poor water supplies or pressure

References

Generic risk assessment 1.1: emergency response and arrival at the scene

Approved Document B

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Fire and rescue service terminology
Bridgehead (forward BA entry control point)

Description

A central and advanced control point for occasions where it is necessary for BA to be started up at a distance from the original point of entry to a risk area , whilst remaining in safe air

General considerations

A bridgehead maybe necessary in high rise buildings and large complex structures such as shopping malls. Consider the following points when determining the location of a bridgehead.

- The potential for escalation of the incident
- Safe air necessary to start up BA
- Crew safety and welfare
- Availability of water supplies
- Effective communications fire ground communications, for example, BA wearers and incident commander
- The level of supervision and support necessary
- The distance from the initial point of access to the BA entry control point (ECP)

Inherent benefits	**Inherent hazards**
Minimise travel distance for BA wearers from ECP to location of firefighting operations	Inappropriate location of bridgehead i.e. corridors Escalation of the incident may require bridgehead location to be moved Issues may arise regarding suitable and sufficient firefighting media due to distance from source or vandalism of fire main outlets Bridgehead locations may have occupants from the building evacuating past them Limited space to operate

Fire and rescue service considerations

- Identify firefighting shafts and other elements of fire protection when determining suitable location for bridgehead
- Consider the likely development of the incident when positioning bridgehead
- Ensure that the bridgehead is sited in close proximity to sufficient water supplies e.g. fire main
- Identify evacuation policy and consider the evacuation route of occupants
- Consider establishing a staging area for resources on a floor(s) below the bridgehead

References

Department for Communities and Local Government and Chief Fire and Rescue Adviser - Operational guidance: breathing apparatus (January 2014)

Fire protection – fire detection and alarm
Activation of other systems
Description Links may be provided between fire protection systems such that, when one system operates, the other connected system(s) operate. More than one system may be linked to provide protection for a building

General considerations	
Where there are numerous active fire protection systems in a building, it may be necessary for the activation of one system to cause the activation of other systems. The most common example of this is a fire detection system causing actuation of a smoke control system. However, many other permutations are also possible (for example a sprinkler system actuating a sounder and/or smoke control system). The actuation of other systems is normally achieved through a simple low voltage signal wire (e.g. 5 volt signal), but may also be achieved through a wireless system. It is common for links to other systems to involve some sort of control panel, particularly in fire engineered buildings where a set of logic based decisions may need to be made by the system before activating other systems (e.g. pattern of detector heads leading to smoke control fans being activated in one direction or another).	
Inherent benefits Co-ordination of fire protection systems can minimise the impact of fire on a building and facilitate actions of firefighters.	**Inherent hazards** Inappropriate action may lead to automatic operation or link between systems being negated, leading to worsening of conditions.
Fire and rescue service considerations • Liaise with the Responsible Person, or appointed competent person, to identify what type of system is operating • Check system indicator panel for further information	
References	

Fire protection – fire detection and alarm

Fire detection

Description

The means by which fire, heat and smoke may be detected within a building

General considerations

If a fire detection system is installed within a building, it should meet the standard of BS 5839-1 and 6 for non-dwellings and dwellings respectively. These categories include provisions for life safety (L category systems), provisions for property protection (P category systems) and Manual alarm systems (M category systems).

Automatic fire detection may not be present in many non-residential premises where nothing more is required other than detection by people through observation or smell.

There are various types of detection mechanism which may be present within a building. These may include the following:

Point heat detectors, point smoke detectors, flame detectors, optical beam smoke detectors, aspirating smoke detectors, multi sensor optical and heat detectors, multi sensor carbon monoxide and heat detectors and carbon monoxide fire detectors.

The type of detection mechanism chosen should be reflective of the types of hazards within the building.

Detection mechanisms may also form part of the operating system for additional fire protection systems such as pressure differential systems, automatic door release or smoke and fire dampers.

Figure 17: Fire detector

Inherent benefits	Inherent hazards
Fire detection systems can assist with the location of a fire. The presence of automatic fire detection may indicate the possible departure from recommended fire safety provisions elsewhere in the building. Automatic detection can indicate the spread of unseen smoke and fire throughout the building.	Inappropriate provision of detection may lead to false alarms within the building. Inappropriate provision of detection may lead to the failure of connected fire protection systems (e.g. failure of smoke or fire dampers allowing unseen smoke spread or firespread)

Fire and rescue service considerations

- Liaise with the Responsible Person who will ensure only a competent person operates systems
- Observe alarm panel for further activations

References

Fire protection – fire detection and alarm
Fire alarm
Description Fire alarm systems are designed to alert the occupants of the building of a fire once the fire detection system has detected smoke or heat within an area of the building.

General considerations	
Within buildings where fire engineering has been adopted, fire alarm systems may have been installed to compensate for the potential omission of other fire safety measures. Manual alarm systems with no additional automatic detection may be present within buildings where nobody should be asleep and the fire has been deemed likely to be detected by people before smoke seriously reduces the visibility within escape routes. Fire alarm system controls should be located and isolated as soon as possible in order to avoid high levels of noise during firefighting operations and potential confusion with security alarms.	
Inherent benefits Fire alarms can assist with the location of a fire	**Inherent hazards** Manual alarm systems may not give an accurate indication as to the location of the fire itself. If the alarm system cannot be shut down this may cause communication problems due to high noise levels during firefighting operations.
Fire and rescue service considerations • Liaise with the Responsible Person who will ensure only a competent person operates systems • Observe alarm panel for further activations	
References Approved Document B Generic risk assessment 3.1: fighting fires in buildings	

Fire protection – fire detection and alarm	
Panels	
Description Panels provide overall control and connectivity between fire detection and fire alarms	

General considerations	
Subject to the complexity of a building and the category of fire alarm system installed, a fire alarm panel may be provided to communicate with and control all of the other components in the system. There are a wide range of panels that are available and may be in use in any building. A panel which is well designed and/or familiar to users may provide an indication of where fire has started or the extent of smoke spread throughout a building. However, panels may be difficult to operate and/or provide misleading information. Panels may be designed to activate other fire protection systems	
Inherent benefits	**Inherent hazards**
Fire detection systems can assist with the location of a fire. Automatic detection can indicate the spread of unseen smoke and fire throughout the building.	Inappropriate provision of detection may lead to false alarms within the building. Inappropriate provision of detection may lead to the failure of connected fire protection systems (e.g., failure of smoke or fire dampers allowing unseen smoke spread or firespread)
Fire and rescue service considerations • Liaise with the Responsible Person who will ensure only a competent person operates systems • Observe alarm panel for further activations	
References	

Fire protection - other
Fire safety engineering
Description Fire safety engineering is the application of scientific and engineering principles based on an understanding of the phenomena and effects of fire and of the behaviour of people to fire, to protect people, property and the environment from the destructive effects of fire.

General considerations

Fire safety engineering uses calculations and quantitative data on numerous topics including:

- Ignition
- Fire growth
- Compartment fire behaviour
- Production of smoke and toxic gases
- Structural response
- Fire detection
- Fire suppression
- Human behaviour
- Firefighting

Fire engineering may only intend to provide life safety protection for the building occupants but it may also be required to achieve property protection, environmental protection or particular facilities to assist firefighters. Where fire engineering is providing life safety protection, the key parameters are the Available Safe Egress Time (ASET) and Required Safe Egress Time (RSET). The ASET tends to be a function of the fire hazard in the building and the fire protection measures in place to mitigate against that hazard. RSET tends to be a function of the number of people in the building and their state (e.g. awake or asleep) as well as the available escape routes and their length. ASET must be kept larger than RSET for a fire engineering solution to be successful.

Fire engineers are required to make specific consideration of the needs of firefighters in carrying out their activities for the protection of relevant persons. The reason for this is that, even in buildings not requiring measures in B5 of Approved Document, consideration is given to the need to provide suitable access routes for firefighters within the means of escape guidance in B1 of the Approved Document.

Inherent benefits	**Inherent hazards**
	It may not be immediately apparent to attending fire officers what the fire engineering strategy is for a building. Given that fire engineering may only intend to provide life safety protection for the building occupants, structural collapse may present a risk to

	firefighters at an earlier stage in the fire than would be the case in a building that does not use fire engineering.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, for advice on fire engineered strategy or solution
- Consider sources of information regarding engineered solutions e.g. Site Specific Risk Information (SSRI), building plans
- If the development exceeds the predicted fire size, the engineered solution may not control smoke travel and fire development
- Firefighting activities may have a detrimental effect on systems e.g. gas cooling
- Facilities provided for firefighters may not take account of the risks to firefighters that may be created by fire safety engineering, for example extended travel distances

References

BS 7974:2001 – Application of fire safety engineering principles to the design of buildings. Code of practice.

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings.

Approved Document B, paragraph B5.ii

Fire protection - other

Emergency lighting

Description

Lighting provided for use when the supply to the normal lighting fails

General considerations

Emergency lighting is intended to provide lighting when supply to the normal lighting fails. In addition to this, emergency escape lighting refers to the part of the emergency lighting that is provided to ensure that escape routes are illuminated at all material times.

Escape lighting, including emergency escape lighting should be provided in accordance with Table 9 from Approved Document B as seen below.

Table 9 **Provisions for escape lighting**

Purpose group of the building or part of the building	Areas requiring escape lighting
1. Residential	All common escape routes (1), except in 2-storey flats
2. Office, Industrial, Storage and Other non-residential	a. Underground or windowless accommodation b. Stairways in a central core or serving storey(s) more than 18m above ground level c. Internal corridors more than 30m long d. Open-plan areas of more than 60m²
3. Shop and Commercial and car parks	a. Underground or windowless accommodation b. Stairways in a central core or serving storey(s) more than 18m above ground level c. Internal corridors more than 30m long d. Open-plan areas of more than 60m² e. All escape routes to which the public are admitted (1) (except in shops of three or fewer storeys with no sales floor more than 280m², provided that the shop is not a restaurant or bar)
4. Assembly and Recreation	All escape routes (1), and accommodation except for: a. accommodation open on one side to view sport or entertainment during normal daylight hours
5. Any Purpose Group	a. All toilet accommodation with a floor area over 8m² b. Electricity and generator rooms c. Switch room/battery room for emergency lighting system d. Emergency control room

Notes:

1. Including external escape routes.

Figure 18: Emergency lighting unit

Figure 19: Emergency lighting unit

Inherent benefits	Inherent hazards
If the emergency lighting is on, this is an indication that the electrical system has been affected by the fire.	Emergency lighting may not provide adequate illumination for conducting fire service operations

Fire and rescue service considerations

- Emergency lighting must not be relied upon for fire service purposes, due to limited illumination and time of operation
- Fire service lighting should be implemented where light conditions are not suitable

References

Approved Document B

Fire protection – other

Collars

Description

Devices designed to prevent the passage of fire and/or smoke within pipework and around the perimeter of pipework between the outside of the pipe and the wall through a line of fire resisting construction.

General considerations

Collars are generally installed with services of smaller diameter or cross sectional area than ductwork and ventilation, such as pipework and drainage.

Collars work by means of an intumescent wrap which expands under the influence of heat in order to prevent the spread of smoke and fire beyond a line of compartmentation.

The considerations of collars are very similar to those of dampers in that collars may be incorrectly installed or installed in the wrong place. Poor maintenance may also lead to failure of the collar in a fire situation

Inherent benefits	Inherent hazards
Prevent the spread of fire and smoke between compartments.	Failure of collars can allow for undetected firespread within and around pipework.

Fire and rescue service considerations

- Investigate areas adjacent to known fire compartments for undetected firespread including concealed areas false ceilings and ducting
- Consider the use of thermal image cameras

References

Fire protection – other
Dampers
Description Devices designed to prevent the passage of fire and smoke within ductwork or ventilation beyond a line of fire resisting construction.

<table>
<tr><td colspan="2">General considerations

Dampers come in the form of fire dampers and smoke and fire dampers. These are designed to prevent the passage of fire and, smoke and fire respectively.

Dampers will be activated either by a thermally activated fusible link mechanism usually in the case of fire dampers or by a smoke detector activated automatic release mechanism, usually in the case of fire and smoke dampers. Dampers may also consist of a combination of each of these mechanisms.

Where thermally activated fire dampers are installed there is a possibility for cooled smoke to spread undetected past the damper and into neighbouring compartments.

Dampers should be located within the thickness of the fire resisting construction, be that the wall, floor or ceiling, with adequate means of access provided to the damper for means of maintenance and repair. Where this is not possible and the damper is off set from the line of fire resisting construction, fire resisting ductwork should be installed running from the damper to the line of fire resisting construction.

The lack of obvious means of access can be a good indication to the fire and rescue service of poor damper maintenance within the building and the potential for unseen firespread within the ventilation and ductwork to adjacent compartments.

Fire dampers may not be provided in all buildings. This may be down to the fire strategy of the building providing for immediate evacuation of a building in which case fire dampers are deemed unnecessary for safe means of escape.

Fire dampers may also be located in the wrong place (i.e. redundant). This can make unseen smoke spread unpredictable.</td></tr>
<tr><td>Inherent benefits

Dampers should prevent the spread of fire and smoke within ductwork and ventilation between compartments.</td><td>Inherent hazards

Failure of dampers can allow for undetected firespread within ductwork and ventilation.

During a fire, expansion of the ductwork may push the fire damper through the element of fire resisting construction which may cause localised non-structural collapse as well as failure of the line of fire resisting construction to maintain its required fire resistance and allow for spread of smoke and fire.</td></tr>
</table>

Fire and rescue service considerations

- Investigate areas adjacent to known fire compartments for undetected firespread including concealed areas false ceilings and ducting
- Consider the use of thermal image cameras

References

Fire protection - other

Signage

Description

For occupants, particularly those unfamiliar with the building to use the building safely with regard to fire safety.

General considerations

Figure 20: Fire safety signs

Signage is designed to assist means of escape and the safe use of the building particularly for those who may be unfamiliar with the building.

A sign may also be defined as something that is illuminated or gives an acoustic signal which provides information on escape routes and emergency exits in the event of a fire, or gives information on the location or identification of firefighting equipment.

Fire safety signs may come in the form of exit signs, fire information boards, fire door signage and indication of the location and type of fire extinguishers and alarm call points.

Fire safety signs should be located where they are clearly visible by occupants and least likely to be obscured by smoke in the event of a fire. Despite this the majority of fire safety signage in and around the location of the fire is likely to have been obscured by smoke by the time the fire and rescue service arrive to carry out firefighting operations.

Inherent benefits

Signage can assist in efficient exit from building or provide assistance if lost.

Good signage can encourage safe use of the building by occupants prior to the fire and rescue service arrival for example fire doors kept shut and effective safe evacuation procedures being correctly followed in the event of a fire.

Poor signage can be an indicator to the fire and rescue service upon arrival of poor general fire safety provisions within the building.

Inherent hazards

Fire and rescue service considerations

- Building signage should not be relied on for suitable access egress routes

References

The Health and Safety (Safety Signs and Signals) Regulations 1996. (As referred to within Approved Document B therefore providing a legal presumption of conformity with part B of the Building Regulations).

Internal fabric
Plaster and plasterboard
Description Plaster is generally applied to walls as a mixed product where it is allowed to dry and set. Plasterboard is generally formed from an inner layer of gypsum between two outer layers of lining paper.

General considerations

Plaster is used to provide a decorative (usually smooth) finish to walls and ceilings. Its main component is normally gypsum, although lime plaster and cement plaster are also in specific and historic (e.g. lath and plaster) applications.

Plasterboard may be used to line partition walls which may be constructed from timber or metal stud. Plasterboard may also line blockwork walls through the method of dot and dab.

Plasterboard generally comes in 9mm and 12.5mm thicknesses, though a wide range of thicknesses are available. Various additives within the gypsum layer along with the weight and strength of the lining paper will give the plasterboard its final properties.

Gypsum is made from crystals which contain a small amount of water. In a fire this water is driven off which may help to keep the temperature of the fire down and may also help prevent rapid firespread.

Figure 21: Plasterboard

Plasterboard is commonly used to provide some level of passive fire protection, particularly to frame structures and stud partitions, as well as to the underside of floors (as ceilings).

Plaster and plasterboard tend to perform well and predictably during a fire, although they is easily disturbed by firefighting jets and can fall away in large sections once wetted.

Inherent benefits	**Inherent hazards**
Plasterboard is non-combustible and may help to prevent rapid firespread. Plasterboard lining stud partition may be easily destroyed or removed by the fire and rescue service during a fire incident if required for access or ventilation.	Plaster and plasterboard can fail suddenly if firefighting jets are applied to them.

Fire and rescue service considerations

- Consider effects of fire (duration and intensity) or firefighting actions (use of jets) on integrity.
- Consider likely age and condition of plasterboard
- Consider quality of workmanship, plasterboard poorly installed may result in early failure, particularly if

damaged
References

Internal fabric
Sandwich panels
Description Insulating panel systems generally consisting of a metal skin and containing either expanded polystyrene, polyurethane or mineral fibre. The panels may be from 50-200mm in thickness and may be faced with PVC for hygienic purposes where applicable.

General considerations	
Insulating core panel systems are used for internal structures as well as for external cladding. Sandwich panels consist of an insulating material between two metal (usually steel) faces which provide rigidity and robustness to the panel. The insulating material may be combustible or non-combustible. They are used to provide highly insulated spaces within buildings. The degradation of polymeric materials can be expected when exposed to radiated or conducted heat from a fire, with the resulting production of large quantities of smoke. It is recognised that the potential for problems in fires involving non-combustible or limited combustibility mineral fibre cores is generally less than those for combustible polymeric core materials. Irrespective of the type of core material, the panel, when exposed to the high temperatures of a developed fire, will tend to delaminate between the facing and core material, due to a combination of expansion of the metal facing and softening of the bond line. Therefore once it is involved, either directly or indirectly in a fire, the panel will lose most of its rigidity. Stability will then be dependent on the method of fixing to the structure. For systems that are not fixed through both facings the stability of the system will then depend on the residual structural strength of the non-exposed facing, the interlocking joint between panels and the fixing system. Most jointing or fixing systems for these systems have an extremely limited structural integrity performance in developed fire conditions. If the fire starts to heat up the support fixings or structure to which they are attached, then there is a real chance of total collapse of the panel system. Where panels are used as the lining to a building the insulating nature of these panels, together with their sealed joints, means that fire can spread behind the panels potentially unseen. With some thermoplastic cores fire can also spread between the panel facings.	
Inherent benefits	**Inherent hazards** The core materials of sandwich panels are difficult to identify when fully installed. The insulating properties of sandwich panels may make it difficult to track firespread even using infra-red detection equipment. Hidden firespread may occur within panels with thermoplastic cores. Production of large quantities of black toxic smoke are likely to occur when sandwich panels are

<table>
<tr><td></td><td>exposed to fire.

The insulating properties of the core materials within sandwich panels may contribute to rapid flashover.

The delamination of the facing material may ultimately lead to rapid structural collapse.</td></tr>
<tr><td colspan="2">Fire and rescue service considerations

• Investigate for potential undetected firespread leading to rapid failure and collapse

• Investigate for firespread into building through openings in walls and roofs</td></tr>
<tr><td colspan="2">References

Approved Document B

Morgan, P and Shipp, M. P. Firefighting Options for Fires Involving Sandwich Panels, publication number 3/99. Home Office. Fire Research and Development Group, 1999.

Generic risk assessment 3.1: fighting fires in buildings

Sun Valley Limited (Hereford and Worcester Fire and Rescue Service, 1993)</td></tr>
</table>

Internal linings
Cables fixed to surfaces
Description Cables can be fixed to the internal substrate of a building, including in means of escape corridors, with a variety of different fixing types.

General considerations	
Cable fixings and cables can become damaged by heat from smoke and flames resulting in the cables falling down. This can be either within the fire compartment or can be within a corridor leading to the fire compartment if the temperature of the gaseous layer is hot enough. This is dependent upon the type of fixing and can also be dependent upon the substrate the cables are fixed to.	
Inherent benefits	**Inherent hazards** Cables can fall or drop from their fixings and firefighters can get trapped in the cables. Dropped or fallen cables can be difficult to see through smoke
Fire and rescue service considerations • Consider the controlled release of cables from trunking or fixings if they may be affected by heat and become loose • Identify alternative access and egress routes to avoid contact with loose cables • Secure loose cables by suitable means and consider removing them if the electricity supply has been isolated and secured • Consider using specialist equipment, such as anti-entanglement covers/straps and cable cutters	
References Approved Document B Shirley Towers (Hampshire Fire and Rescue Service, 2010)	

Internal linings
Decorative
Description Decorative linings include wallpaper, paint and fixings to walls for example posters, picture frames etc.

General considerations

The decorative linings within a building cannot be controlled by the Building Regulations as these are generally affected by the occupants of the building and may accumulate over time.

It is down to the Responsible Person within the building to carry out a risk assessment in order to maintain fire safety within the building and this includes assessing the effects of any pre or planned decorative works in order to maintain the surface spread of flame characteristics required within guidance.

Layers of paint applied to a substrate over time may create a layer sufficiently thick to become flammable. Therefore the surface spread of flame characteristics of the lining within an area may not be limited to the extent that may be expected within for example an area of means of escape and may instead contribute significantly to firespread as well as toxic fume emission.

Evidence suggests that all existing paint films of unknown origin and of whatever age, thickness and condition should be considered potentially flammable.

Additional factors which may contribute to this may be large amounts of graffiti, often found within communal areas of blocks of flats.

Consideration must also be given to the effects of other general decorative additions to linings such as posters, wall paper or large amounts of wooden picture frames or internal cladding design features of a combustible nature.

Inherent benefits	**Inherent hazards**
By the Fire Safety Order it is the duty of the Responsible Person within the building to ensure through the carrying out of risk assessments that any redecoration process will not downgrade the performance of the building surfaces when exposed to fire.	There is a lack of control by the building regulations once a building has been handed over to the owner and occupants. Thick layers of paint may become flammable and significantly contribute to spread of fire and the emission of toxic fumes

Fire and rescue service considerations

- Consider any potential influence that decorations may have on fire development
- Consider use of thermal image cameras

References

Approved Document B

Code of Practice – Refurbishment of Communal Buildings and the Fire Risk of Multilayer Paints, 2005

King's Cross Underground Fire (London Fire Brigade, 1987)

Internal linings
Substrate
Description This is the outer most layer of any internal element of construction.

General considerations	
Internal lining substrates may include plaster, masonry, timber sheaving, plasterboard, steel. Spread of flame properties for internal linings are generally controlled, but particularly in circulation spaces where Class 0 is required. The definition comes from the test methods that are used in its assessment but can generally be considered to mean that a surface has limited combustibility.	
Inherent benefits Internal lining substrates come under building controls with regard to lining spread of flame	**Inherent hazards** Lack of building controls with regard to substrate material selection can lead to significant effects on the spread of fire and rate of fire growth within an area.
Fire and rescue service considerations • Consider effects of fire (duration and intensity) or firefighting actions (use of jets) on integrity. • Consider age and condition	
References Approved Document B BS 476-7:1997 – Fire tests on building materials and structures. Method of test to determine the classification of the surface spread of flame of products. BS 476-6:1989 – Fire tests on building materials and structures. Method of test for fire propagation for products.	

Layout
Atrium
Description An atrium is a large open space passing through several floors of a building and enclosed at the top.

General considerations

An atrium is an open connection (internal space) confined within a building which passes up through a number of storeys of the building. An atrium is defined in approved guidance where it passes up through compartment floors, however they may also exist passing up through non-compartment floors.

Figure 22: An atrium

Atriums are commonly present as an architectural feature within the building, often performing more than on function for the building overall. They are often used as a light well permitting light to pass through the roof structure (often using glass, plastics such as ethylene tetrafluoroethylene (ETFE) or other transparent material) deep into the building. Additionally atriums may be used for internal vertical circulation commonly incorporating escalators, lifts and communication stairs. Atriums are sometimes used as an integral part of a heating and ventilation system and smoke control system.

Atriums provide a passage by which smoke, and the products of combustion, may pass up through a building and affect multiple floors. However fire protection measures such as smoke control and suppression systems may be designed into an atrium to either mitigate the risk of this occurring or permitting the spread of smoke and products of combustion but in a controlled manner. Controls on the fuel loading within atrium spaces may also be imposed in order to limit the size of fire in these areas.

Firefighting water applied at high levels within an atrium may run down the open void connection within the building causing flooding below.

Familiarisation visits may help firefighters to understand how the hazards associated with atriums apply to a particular building.

Fire safety management within the building will be important to mitigate the hazards associated with atriums.

It would not be uncommon to find that buildings incorporating atriums may have been designed to meet the functional objectives of the building regulations through the application of fire safety engineering.

Inherent benefits	**Inherent hazards**
Atriums may provide a large smoke reservoir. The presence of fire-engineered solutions (e.g. fire-resisting glass) and active suppression and smoke control is more likely in atriums, particularly atriums which penetrate compartment floors.	Atriums may allow faster and more extensive smoke and firespread between floors, and may allow smoke to spread into the escape routes of upper floors. There is potential for smoke stratification in atriums.

Atriums can provide a quick indication of fire location by providing a clear line of sight through several floors of the building.	Failure of glazing around the edge of an atrium may cause issues with firefighters working at height. It may be difficult to identify whether the floors through which an atrium passes are compartment floors or mezzanines. There is an increased reliance on fire protection measures to prevent firespread through atriums.

Fire and rescue service considerations

- Liaise with the Responsible Person for advice on using any integrated systems; only competent persons should operate any integrated systems. Ensure tactical plan does not compromise systems.
- Identify whether the atrium passes through non-compartmented floors
- Consider protecting escape routes on floors not affected by fire, due to possibility of smoke spread
- Investigate areas adjoining atrium for fire and smoke spread
- Consider the effects of water and possible build up in the atrium during firefighting operations
- Identify any fire or smoke control systems which may be incorporated into the atrium
- Consider the effects of fire engineered solutions

References

Design Principles of Fire Safety, Department of the Environment, May 1996

Layout
Auditorium
Description
An auditorium is a room built to allow an audience to watch and hear a performance. This includes theatres, cinemas, concert halls and lecture theatres.

General considerations

An auditorium is an area specifically for an audience to witness an event, commonly lecture, film or theatrical performance. Auditoriums are found within many different buildings and depending upon the nature of the building however the key points of note for the auditorium will commonly remain constant.

Figure 23: An auditorium

The majority of auditoriums will consist of a large compartment incorporating inclined seating across one, two or three sides. This seating will be a very densely populated area. The escape routes from this seating area will normally be at high and low level, with limited egress routes often defined by the seating itself.

Auditoriums associated with modern buildings will normally have means of escape designed to current, or relatively current design guidance, and therefore the population from such areas should be expected to evacuate in a reasonable time. Means of escape associated with older buildings incorporating auditoriums, older theatres etc., will not have been designed to modern standards thus there could be extended escape times.

Modern buildings incorporating auditoriums, cine-complexes etc., may have many auditoriums within them.

Familiarisation visits may help firefighters to understand how the hazards associated with an auditorium apply to a particular building.

It would be expected that the Responsible Person should be on duty when an auditorium is occupied.

Within theatres where auditoriums are present it would be expected that there should be suitable fire separation between the front and back of houses. Within the back of house accommodation whilst the population may be lower as is normally limited to the cast and crew the fire risks can be greater due to the amount of materials being used in items such as props and scenery.

Some larger and complex buildings may have auditoriums split over many tiers.

Within large and complex auditoriums there is a greater likelihood of fire engineering strategies to be employed in the building design.

Within auditoriums there will be a greater prevalence for vertical escape requirements.

Inherent benefits	Inherent hazards
An auditorium is designed to admit large numbers of people to the public areas, and therefore should have good access and means of escape An auditorium is likely to have fire protection measures in place. Proscenium arch theatres will usually have haystack lantern lights above the stage to vent smoke from fires in the stage area and a fire curtain to prevent firespread from the stage to the public areas.	The layout of a building containing an auditorium may be complex and may contain high fire loads from props and other items associated with the performance. An auditorium is likely to contain overhead hazards such as lighting, projectors, speaker systems and props. Backstage areas may include concealed and confined spaces. Access to non-public areas is likely to be restricted and this may hinder search and rescue operations. Hazards associated with atriums may also be present in auditoriums which occupy more than one floor of a building.

Fire and rescue service considerations

- Initial access to premises may be hindered by escaping staff and members of the public
- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems, identify drencher systems
- Utilise available access and egress points around auditorium to reduce travel distances for firefighting and rescue teams
- Thorough briefing of crews working in upper viewing areas due to steep access ways and low balcony protection
- Exercise extreme caution when operating in stage areas consider suspended hazards such as items used to counterbalance scenery and props
- Consider protecting escape routes on floors not affected by fire due to possibility of smoke spread
- Identify if fire curtain is deployed separating stage area
- Investigate areas adjoining auditorium for fire and smoke spread
- Consider the effects of water and possible build up in auditorium during firefighting operations
- Identify any fire or smoke control systems which may be incorporated into the auditorium
- Consider the effects of any fire engineered solutions
- Consider the presence of pyrotechnics
- Consider the use of thermal image cameras

References

Licensing Act 2003 (includes theatres)

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001 – chapter 7.18.2, pp 121-123.

The Station nightclub fire (United States, 2003)

Layout
Cellular
Description A cellular room arrangement is where an area of a building is divided into individual rooms commonly served by common corridors.

General considerations

Cellular room arrangements are commonly found where a large area is divided in to smaller rooms (or compartments) to provide the users privacy whilst the building is occupied. This kind of arrangement is common in older style office and educational buildings. Additionally some modern buildings may have a degree of cellularisation within a larger open plan space to provide breakout and/or meeting rooms.

Cellular rooms will commonly be an inner room. Although some cellular rooms may have interconnecting doors or sliding partitions.

Within traditional buildings the cellular spaces are often created by more robust construction whereas modern buildings the cellular construction is often provided by lightweight materials and glazing systems.

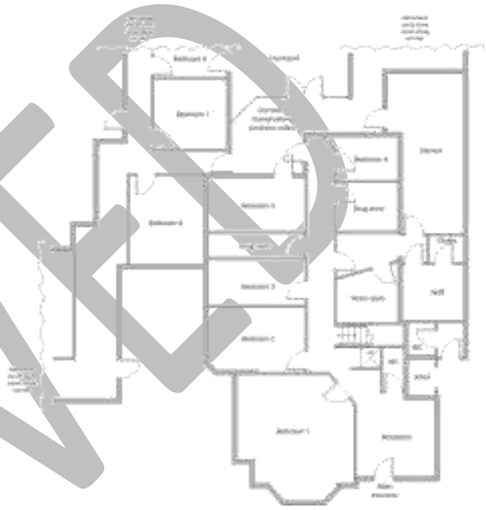

Figure 24: Floor plan of typical cellular layout

Inherent benefits	Inherent hazards
Buildings with a cellular layout are likely to have better-protected and more well-defined escape routes. The dividing walls found as part of a cellular layout may help to contain a fire to a smaller area.	The presence of dividing walls and rooms with more than one entrance increases the complexity of search and rescue operations. Buildings with a cellular layout may have complex layout and excessive travel distances. It may be hard to differentiate between walls which have a load bearing or fire resisting function and those which only act to divide space between different rooms. Partition walls may not continue above a false ceiling to the floor slab above, which may allow unseen firespread in ceiling cavities between rooms.

Fire and rescue service considerations

- Consider the likelihood of undetected firespread
- Identify access and egress points to any areas comprising cellular layouts
- Consider the use of thermal imaging cameras
- Consider potential firespread through partitions and protect adjoining spaces

References

Layout
Open-plan
Description An open-plan layout is where almost the whole floor area of a storey consists of one open space minimally sub-divided into smaller rooms.

General considerations

Open storey planning, or open-plan layout, is an arrangement in which the majority of the floor area of a storey consists of an open space which is not divided by walls. However, the presence of screens or furniture may produce a pseudo-cellular layout, and an open-plan space may include some cellular rooms if it is desirable to the occupant to separate certain functions e.g. meeting rooms and refreshments. Cellular rooms within an open-plan space are likely to be separated from the larger space by lightweight partition walls rather than more heavyweight construction which would be more commonly found in a fully cellular layout.

It would be expected that all aspects of a building that are required to be fire resisting, such as protected escape stairs, would be enclosed within fire resisting construction.

Inherent benefits	**Inherent hazards**
Firefighters may be able to see across an entire open-plan space without walls obstructing their vision. Occupants are more likely to be aware of fire or smoke at an early stage in an open-plan layout compared to a cellular layout, and therefore are less likely to become trapped and require rescue.	An open-plan space is likely to contain a larger fire load within the space when compared to a cellular layout but will allow wider fire and smoke spread than a space which is sub-divided into rooms. As a result, a fire may affect a greater proportion of the space. The potential for rapid fire development is greater in open planned space and greater resources may be required than for a similar incident in a cellular building. If the occupants of an open-plan space change the layout or use of that space, previous familiarisation visits may become misleading.

Fire and rescue service considerations

- Consider the need for a greater number of resources
- Liaise with the Responsible Person for up to date floor plan and advice on using any integrated systems, only competent persons should operate any integrated systems
- Consider protecting adjacent areas and floors above and below
- Consider the use of thermal imaging cameras

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings

Telstar House (London Fire Brigade, 2003)

Layout
Stadiums
Description Field or stage completely or partially surrounded by structure which allows spectators to view an event, commonly sport or musical performance.

General considerations

Like an auditorium, a stadium is designed specifically to allow an audience to witness an event, which in a stadium is commonly a sporting or musical event. Stadiums are usually purpose-built buildings and may be indoor (with an overall roof) or outdoor (where the playing or performance area is uncovered and some or all of the spectator accommodation may be covered).

Figure 25: Wembley Stadium

A stadium may consist of a single, unified structure or a collection of structures such as individual stands, changing rooms and refreshment facilities. Where a stadium consists of separate structures, these may be of varying age and design. It is more common for newer, larger and indoor stadiums to consist of a single structure and for older, smaller and outdoor stadiums to consist of separate structures, either by design or as a result of alterations during the life of the stadium. A stadium may completely surround a pitch or stage but in the case of smaller stadiums and those on restricted sites, the pitch or stage may only be partially surrounded.

Spectator accommodation will be inclined and may include separate areas for spectators to stand or sit. These areas will be densely populated and standing areas are likely to be more densely populated than seated areas. Escape routes may be at the front, back and/or middle of spectator areas and will often lead to a concourse underneath. Stadium buildings may also contain facilities such as shops, bars and restaurants either for event spectators or the general public.

It would be expected that the Responsible Person should be on duty when a stadium is occupied. In larger stadiums, the functional objectives of the building regulations may have been met by the application of fire safety engineering. Familiarisation visits may help firefighters to understand how the hazards associated with stadiums apply to a particular building.

Inherent benefits	**Inherent hazards**
A stadium is designed to admit large numbers of people to the public areas, and therefore should have good access and means of escape. A stadium is likely to have fire protection measures in place.	The internal layout of a stadium, particularly one consisting of many adjoining structures, may be complex and may contain high fire loads from plastic or foam sports training equipment, or from props associated with a musical performance. Access to non-public areas may be restricted and this may hinder search and rescue operations. A stadium may also be designed to give limited access

	between certain areas e.g. to keep supporters of opposing sports teams apart. Hazards associated with atriums and auditoriums may also be present, particularly in indoor stadiums.

Fire and rescue service considerations

- Identify the type of construction material of seating as this may increase potential fire development
- Initial access to premises may be hindered by escaping staff and members of the public
- Ensure fire and rescue service arrival and access does not compromise route of escaping members of the public or staff
- Identify control room and liaise with the Responsible Person to utilise CCTV and for advice on using any integrated systems, only competent persons should operate any integrated systems
- Consider the need for working at height procedures or aerial appliances
- Thorough briefing of crews working in upper viewing areas due to steep access ways and low balcony protection
- Exercise extreme caution when operating in stage areas consider suspended hazards such as items used to counterbalance props and props
- Consider protecting escape routes on floors not affected by fire due to possibility of smoke spread]
- Identify any fire or smoke control systems which may be incorporated into the stadium
- Consider the effects of any fire engineered solutions
- Consider the effects that wind may have, on the fire, in open stadium as the wind may behave unexpectedly due the effects of the structure

References

Bradford City stadium fire (West Yorkshire Fire and Rescue Service, 1985)

Hillsborough Stadium disaster (South Yorkshire Fire and Rescue Service, 1989)

Means of escape and access – height or depth
Ground floor only
Description A building with a single habitable floor which is accessed from ground level

General considerations	
It should be possible to access the building via any opening (e.g. door or window) due to them being within easy reach of personnel from outside. It is possible that a building which appears to be a ground floor only building from the outside may consist of a mezzanine, gallery or raised storage area within. It is also possible that there may be a basement or loft conversion within the building.	
Inherent benefits	**Inherent hazards**
It is unlikely that the building will contain high platforms, stairs and lifts. Doors and windows for escape, access and ventilation should be easily accessible from the outside of the building. Final exit doors are likely to be distributed evenly around the perimeter of the building.	There is likely to be little or no provision of fire resistance to the structure of the building.
Fire and rescue service considerations	
References Approved Document B The Regulatory Reform (Fire Safety) Order 2005 BS 7974:2001 – Application of fire safety engineering principles to the design of buildings. Code of practice. Party wall building studs	

<table>
<tr><td colspan="2">Means of escape and access – height or depth</td></tr>
<tr><td colspan="2">Two-storey</td></tr>
<tr><td colspan="2">Description
A building with two habitable levels above ground level.
A storey may include any galleries within an assembly building or any gallery in any other type of building where the area of the gallery is over half that of the area above which it protrudes.</td></tr>
</table>

<table>
<tr><td colspan="2">General considerations
In general means of escape provisions for buildings up to 18 m high are sufficient to allow for the safe access and egress of firefighters.
Fire resistance to the structure should be in place; however compartmentation between stories may or may not be in place within a two-storey building.
Fire escape windows are normally present based upon the premise that they will be within reach of pump ladder appliances, allowing for both rescue of occupants and access by fire service personnel.
The possibility of non-ambulant occupancy and people trapped on upper floors should also be considered.</td></tr>
<tr><td>Inherent benefits
Pitching ladders to a two-storey building should allow for similar access opportunities to a ground floor arrangement.
Two-storey buildings are a common building stock and therefore should be familiar to firefighters and regularly addressed in firefighting training.</td><td>Inherent hazards
There is the possibility that the building has been converted with a potential for the second storey to exist within a roof space.
The building may also include a basement.
Firefighting personnel may be required to work at height.</td></tr>
<tr><td colspan="2">Fire and rescue service considerations</td></tr>
<tr><td colspan="2">References
Approved Document B
The Regulatory Reform (Fire Safety) Order 2005
BS 7974:2001 – Application of fire safety engineering principles to the design of buildings. Code of practice.
Party wall building studs</td></tr>
</table>

Means of escape and access – height or depth

Three-storey

Description

A building with three habitable levels above ground.

A storey may include any galleries within an assembly building or any gallery in any other type of building where the area of the gallery is over half that of the area above which it protrudes.

General considerations

Three-storey buildings are more likely to be subdivided into multiple occupancies. They are also more likely to have been converted and are more likely to be older buildings which are less likely to have modern levels of fire protection.

Protection to staircases in old townhouses, if present, is likely to be compromised due to occupants leaving doors open.

Can be difficult to locate door access from staircases to converted areas of dwellings.

The possibility of non-ambulant occupancy and people trapped on upper floors should also be considered.

Fire escape windows are normally present based upon the premise that they will be within reach of pump ladder appliances, allowing for both rescue of occupants and access by fire service personnel.

Inherent benefits	Inherent hazards
Accessible by ladder. Three-storey buildings are likely to have a greater period of fire resistance than two-storey or ground floor only buildings. Well represented within the current building stock and therefore should be familiar to firefighters.	More likely to have a compromised means of escape or stairwell protection. Access issues with office blocks with shared tenancy and separate security issues. May encounter larger compartment sizes.

Fire and rescue service considerations

References

Means of escape and access – height or depth
Less than 18m (<18m)
Description A Building whose upper most habitable floor is less than 18m above ground level measured from the lowest side of the building.

General considerations In general means of escape provisions for buildings up to 18 m high are sufficient to allow for the safe access and egress of firefighters. Firefighting shafts are unlikely to be available, however buildings with a large footprint (>900m^2) may be provided with a firefighting shaft. There is an increased likelihood of atrium design within the building. Defend in place may be adopted within the fire safety management of the building. The possibility of non-ambulant occupancy and people trapped on upper floors should also be considered.	
Inherent benefits Dry risers may be present within buildings with a large footprint or restricted firefighter vehicle access, however these may not be located within a firefighting shaft. Firefighting shafts may be present within buildings with a large footprint or restricted firefighter vehicle access. Structural fire resistance will be in place. There is an increased likelihood of active fire protection	**Inherent hazards** Increased likelihood of multiple occupancy. Population may still be evacuating upon arrival Expectation of reliance on firefighting aerials at this height. Increased vertical travel distances. People may attempt to use general lifts as a means of escape. Firefighting lifts are unlikely to be provided. Complexity of means of escape will increase i.e. defend in place and how it is put into practice.
Fire and rescue service considerations • Liaise with the Responsible Person, or appointed competent person, for advice on fire engineered strategies • Consider sources of information for example SSRI, building plans • Consider presence of facilities for firefighters for example lobby protection	
References Approved Document B	

Means of escape and access – height or depth
Greater than 18m and less than 30m (>18 and <30m)
Description A building whose uppermost habitable floor is less than 30m and greater than 18m above ground level measured from the lowest side of the building.

General considerations	
Provisions for firefighters at building heights greater than 18m will increase. One of the main factors driving this is the elimination of access from the outside of the building via the use of a standard firefighting turntable. The additional provisions for firefighters and the design of the building should aim to mitigate this additional risk. Risk mitigating factors will include Class 0 external surface requirements for the envelope of the building at heights greater than 18m. Buildings over 18m in height should also include firefighting shafts with firefighting lifts and will have an increased period of structural fire resistance depending upon the presence of a suppression system within the building.	
Inherent benefits Increased fire resistance. Additional provisions to assist firefighters. Provisions should be in place to limit external firespread from the building	**Inherent hazards** External rescue is limited and very difficult at heights above 18m Issues may come into play with regards to wind driven fires. Firefighters should be aware of façade failures and the potential for exposed edges of the building at height. There is potential for the misuse of firefighting facilities by the occupants of the building. Misidentification of floor levels during firefighting operations may also occur.

Fire and rescue service considerations

- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems
- Consider delays due to accessing building and scene of operations
- Secure fire main (dry riser)
- Implement high rise procedure
- Identify safe access and egress routes into the building, consider falling debris
- Consider possibility of wind affecting the fire development
- Implement communications procedure consider utilising integral fixed communications

References

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Means of escape and access – height or depth
Greater than 30m (>30m)
Description A building whose upper most habitable floor is greater than 30m above ground level measured from the lowest side of the building.

General considerations

As with buildings between 18m and 30m, buildings over 30m in height will contain floors at a height, position or design that external firefighting or rescue operations may not be feasible or practicable.

Appliances, ladders, lines and hose will be of limited use on the upper floors of buildings over 30m in height and therefore additional firefighting facilities will be provided within the building to mitigate the additional risk of building height.

Buildings at a height over 30m may be provided with an automatic sprinkler system throughout the building in addition to the provisions of firefighting shafts, firefighting lifts and firefighting stairs, although this may not be the case in older buildings. Wet rising mains should also be installed in modern buildings over 50m in height.

Phased or progressive evacuation is likely to be in place within the building. There is also likely to be a prolonged period of evacuation which may cause firefighters to come into contact with building occupants evacuating during firefighting operations.

Buildings of this height are likely to have a limit to the scale of evacuation possible therefore partial evacuation will be likely with occupants remaining in relatively safe areas of the building during firefighting operations.

Inherent benefits	Inherent hazards
Good firefighting facilities and emergency management should be in place	Fire growth and firespread within the building may be affected by wind, the speed of which generally increases with height. The wind effects felt on the ground are likely to be very different from those at height at that same moment in time. (For additional hazards see Greater than 18m and less than 30m)

Fire and rescue service considerations

- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems
- Consider delays due to accessing building and scene of operations
- Secure *fire main* (wet riser)
- Implement high rise procedure
- Identify safe access and egress routes into the building, consider falling debris
- Consider possibility of wind affecting the fire development

• Implement communications procedure consider utilising integral fixed communications
References Generic risk assessment 3.2: fighting fires in high rise buildings

Means of escape and access – height or depth
Mezzanine, gallery or raised storage areas
Description Additional floors which extend above the footprint of the floor below.

General consideration

A mezzanine floor is a floor that is ancillary to the use of the building and does not exceed more than 20% of the footprint of the floor below or 500m^2 (whichever is less). The mezzanine floor should be compartmented from the lower storey and have a separate means of escape independent to any on the lower storey.

A gallery may be a floor which extends across the footprint of the building and is open to the floor below. Any gallery within an assembly building should be classed as an additional storey. Any gallery covering at least 50% of the building footprint in any other type of building should also be treated as an additional storey (e.g. two-storey or three-storey)

Raised storage areas may be defined as raised platforms similar to mezzanines however these will not provide a separate means of escape from those provided on the floor below, they may also not be compartmented from the floor below.

Inherent benefits	**Inherent hazards**
	Raised storage areas are likely to have minimal provisions for fire resistance and therefore may be susceptible to early collapse particularly if high fire loads have been stored beneath the raised storage area

Fire and rescue service considerations

- Consider cooling of structure to mitigate early collapse
- Identify any fire or smoke control systems which may be installed to protect mezzanine
- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems
- Identify and protect mezzanine egress routes
- Consider the effects of storage systems for example, collapse, falling debris or stock, fire loading on mezzanines

References

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Means of escape and access – height or depth
Deep basement
Description A basement may be described as deep when its lowest floor is more than 10m below the firefighting access level. Basements are also defined as areas requiring upward means of escape.

General considerations Within a deep basement it is likely that each basement level will be separated by a line of fire resisting construction up to and including separation from the ground level storey. Considerations are similar as those for shallow basements; however there may be additional benefits with regard to firefighting facilities.	
Inherent benefits	**Inherent hazards**
A firefighting shaft containing wet falling mains, firefighting lifts and firefighting stairs should be installed providing access to every basement level. Firefighting shafts should also be provided with a pressure differential system. Natural or mechanical ventilation shafts should also be provided.	Basement may not be clearly visible to the fire and rescue service upon arrival. The access route from outside the building or from within the building may not be clear. Basements may behave in a similar way to highly insulated buildings. Lack of natural light. Access routes are likely to be the same as the smoke egress route. Basements are highly insulated spaces and may allow for the possibility of more intense rapid fire growth.

Fire and rescue service considerations

- Early consideration should be for the needs of additional resources
- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems
- Consider the use of the basement and impact on firefighting operations
- Identify suitable access points including firefighting shafts, to commence operations from
- Identify the presence of fixed installations and take control of their operation
- Consider the use of fire service lighting
- Consider the need to rotate crews regularly due to arduous working conditions
- Ensure strict co-ordination of internal and external firefighting must be maintained throughout incident

References

Means of escape and access – height or depth
Shallow basement

Description

A basement may be described as shallow when its lowest floor is not more than 10m below the firefighting access level.

Any floor which at some point is more than 1.2m below the highest level of ground adjacent to the external walls may be classed as a basement.

Basements are also defined as areas requiring upward means of escape.

General considerations

Within a 'shallow' basement only the floor separating the basement from the ground storey may be a compartment floor of fire resisting construction. This means that the basement floor two levels down may not be fire separated from the basement floor above.

'Shallow' basements are likely to exhibit limited access; however the access routes available may be horizontally from the outside or vertically from within the building.

There is likely to be a lack of ventilation within the basement, however some ventilation may be provided by means of pavement lights and doors. There is however a risk of rapid fire development or backdraft during opening of such of vents during firefighting operations.

Fire behaviour in general within basements is unpredictable with little researched knowledge. Structural fire engineering design is also invalid as the assumptions that are made become invalid due to lack of ventilation within basement fires.

Firefighting personnel should consider the possibility that some buildings may extend below ground underneath access roads particularly upon arrival when choosing where to locate appliances

Inherent benefits	**Inherent hazards**
	Basement may not be clearly visible to the fire and rescue service upon arrival. The access route from outside the building or from within the building may not be clear. Access routes are likely to be the same as the smoke egress route Lack of ventilation or lack of natural light Basements are highly insulated spaces allowing the possibility for more rapid fire growth.

Fire and rescue service considerations

- Early consideration should be for the needs of additional resources
- Liaise with the Responsible Person for advice on using any integrated systems; only competent persons should operate any integrated systems
- Consider the use of the basement and impact on firefighting operations

• Identify suitable access points to commence operations from • Identify the presence of fixed installations and take control of their operation • Consider the use of fire service lighting • Consider the need to rotate crews regularly due to arduous working conditions • Ensure strict co-ordination of internal and external firefighting must be maintained throughout incident
References

Means of escape and access – height or depth
Tunnels
Description A tunnel is a passageway which may be above or below ground however is completely enclosed except for openings at its exits commonly at each end of the tunnel. Also see deep basements.

General considerations

Tunnels should be expected to behave in a similar way to basements. There is likely to be limited access to the tunnel and means of access is likely to be the same as the smoke egress route.

There is likely to be a lack of natural ventilation within the tunnel and the tunnel can be considered a highly insulated space. These two aspects create counter influences within tunnel geometries as the highly insulated confined nature of a tunnel means heat is not lost to the atmosphere but tends to remain in the location of the fire. This is countered by the diminishing effect of the lack of inflowing oxygen within the smoke filled tunnel.

The often curved nature of a tunnel ceiling means that smoke spread along its length will be far more rapid than an equivalent fire within a compartment, for example. The smoke layer height is also likely to be reduced compared to that within a compartment fire of the same magnitude.

Pre-planning and familiarisation within tunnel environments likely to be encountered by a fire and rescue service is vital.

Inherent benefits	**Inherent risks**
Control rooms should be available at the tunnel Ventilation controls should be in place. Enhanced fire resistance provisions should be in place.	Access routes are likely to be the same as the smoke egress route. Lack of ventilation or lack of natural light. Tunnels are highly insulated spaces allowing the possibility for more rapid fire growth. Excessive travel distances may be encountered limiting the working duration of firefighters

Fire and rescue service considerations

- Early consideration should be for the needs of additional resources
- Identify travel distance to scene, identify suitable access and egress points through adjacent tunnel if available
- Liaise with the Responsible Person for advice on using any integrated systems, only competent persons should operate any integrated systems
- Assess ventilation options e.g. smoke shafts, ventilation fans, consider the use of PPV
- Identify type of tunnel and associated hazards (Rail, Road or communications tunnels)
- Identify any firefighting shafts, to commence operations from

• Consider the use of fire service lighting
References
Beard, A and Carvel, R. Handbook of Tunnel Fire Safety (Geotechnical and Environmental), 2011

Passive fire protection
Fire compartmentation
Description The sub-division of buildings into areas by fire resisting elements of construction.

General considerations

Fire compartmentation of a building is provided by fire resisting construction with the aim of preventing or delaying the spread of fire and smoke from one space within a building to another, and occasionally, to limit the external firespread from the building.

Fire compartmentation is provided as a system which includes fire resisting floors and fire resisting walls. Where services or other openings within lines of fire compartmentation are required 'opening protective' devices such as fire doors, fire shutters, fire dampers, glazing etc.

Fire compartmentation is not necessarily an element of structure.

The performance criteria of the walls and floors forming the fire compartmentation is recognised as a time rating in reference to a standard fire resistance test. An actual fire scenario may differ from the standard test and therefore the time rating will not accurately reflect the performance which may be achieved by compartmentation on site.

The effectiveness of fire compartmentation relies upon good workmanship at installation and it being in a good state of repair. Non fire stopped penetrations, defects, and lack of maintenance can lead to the early failure of the compartmentation.

The state of compartmentation in the building should be investigated.

Inherent benefits	**Inherent hazards**
Fire compartmentation maintains protected escape and firefighting routes within the building. Compartmentation will help limit the spread of fire within the building. Compartment fires behave in a predictable manner.	Poor workmanship and damage to compartmentation may lead to failure of the fire resisting element of construction and therefore a breach in compartmentation.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, for advice on areas of compartmentation
- Consider the use of CAD plans if available
- Identify areas of compartmentation involved in fire
- Investigate areas adjacent to known fire compartments for undetected firespread including concealed areas i.e. false ceilings and ducting
- Consider that the duration of any fire development may contribute to early failure of compartmental elements such as uPVC door frames or windows

References

Passive fire protection
Fire stopping
Description The means by which the fire resisting properties of a fire resisting element of construction are maintained when penetrations, joints and imperfections are present within the element.

General considerations

If a fire stopping element (line of fire compartmentation) within a building is to be effective, every joint or imperfection of fit or opening to allow services to pass through the element should be adequately protected by sealing or fire stopping so that the fire resistance of the element is not impaired.

Poor fire stopping may not be immediately obvious therefore it is important to check above false or suspended ceiling tiles or below false, or raised access, flooring, for fire stopping to hidden penetrations. This can also be done during a fire incident in order to make a quick assessment of the building and the likelihood of firespread between compartments.

Problems are likely to occur when fire stopping fails in its performance either due to poor fire stopping, often related to poor workmanship or poor maintenance, or lack of fire stopping altogether.

Issues are then likely to include the potentially unseen spread of smoke and or fire between compartments. This firespread can occur both through walls and floors and may be within the pipes and services themselves.

Inherent benefits	**Inherent hazards**
Good fire stopping can restrict the spread of smoke and fire and in a predictable manner.	Poor fire stopping can lead to concealed firespread. Poor fire stopping can lead to smoke and fire compromising multiple areas. These may include additional areas where firefighting operations are taking place, for example compromising the firefighting bridgehead Be aware of unseen firespread through lines of compartmentation separating floors as well as walls.

Fire and rescue service considerations

- Investigate areas adjacent to known fire compartments for undetected firespread for example, concealed areas, false ceilings or floors and ducting
- Consider the use of thermal imaging cameras

References

Passive fire protection
Lining spread of flame
Description A criteria which should be met by the internal wall and ceiling linings so as to limit the contribution that the surface of the fabric of the building has on fire growth.

General considerations

In order to limit the contribution the fabric of the building has on fire growth the internal linings of the building should adequately resist the spread of flame over their surfaces. The term lining indicates the material which makes up the outer most layer of any wall, ceiling, partition or other internal structure.

The performance criteria for the classification of linings is based upon several properties including the ease of ignition of the material and the rate of heat release of the material when burning these classifications, as identified in statutory guidance, are designated as:

- Best performing = Class 0 (National Classification)/ B-s3, d2 (European classification) [example plasterboard], to;
- Worst performing = Class 3 (national classification)/ D-s3, d2 (European classification) [example exposed timber].

The materials or combination of materials making up the linings of a building can contribute significantly to fire growth even though these materials are unlikely to be those first ignited. Lining material choice within a building is particularly important within critical areas such as circulation spaces used for means of escape. Lining materials within such areas should meet class 0 within common areas of blocks of flats or class 1 within circulation spaces in dwellings, therefore providing for the minimum contribution to fire growth.

It is important to note that the reaction to fire of linings does not indicate the fire resisting properties of the element of construction as a whole system.

Inherent benefits	**Inherent hazards**
Controls are in place to provide for the limit of spread of flame in critical areas for means of escape (e.g. circulation spaces)	Multiple layers of combustible paint applied over time where class 0 lining is required as discussed above can have an adverse effect on a linings spread of flame characteristics Older buildings may have combustible linings which were installed prior to these controls being introduced, and so pose a hazard due to surface spread of flame.

Fire and rescue service considerations

- Consider any potential influence that they may have on fire development
- Consider use of thermal image cameras

References

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Passive fire protection
Structural
Description Fire protection added to elements of structure for the purpose of minimising risk to occupants, firefighters and people in close vicinity to the building.

<table>
<tr><td colspan="2">General considerations

Passive fire protection is applied to elements of structure so that these elements can meet the period of fire resistance required for the building.

Some load bearing structure may not be provided with fire protection, for example a structure which only supports a roof or galleries provided for maintenance access only.

Elements of structure may not rely upon after treatments for fire resistance, and may possess an inherent structural fire resistance. However unprotected steel work in buildings above four stories is very unlikely unless particular consideration has been to the thickness of steel used or other fire precautions have been taken.

Poor installation and general workmanship can compromise the performance of passive fire protection. Additionally, damage to passive fire protection can lead to early failure of an element of structure and collapse.

Damage can occur to structural fire protection during firefighting activities, rapid heating and then cooling by fighting water can result in a loss of strength in the structural elements.

Some forms of structural fire protection can form concealed spaces around structural elements, allowing unseen spread of fire to occur.</td></tr>
<tr><td>Inherent benefits

Structural fire resistance will maintain stability of the structure for a period in which means of escape and firefighting will occur.</td><td>Inherent hazards

Missing or damaged fire protection will lead to premature structural failure.</td></tr>
<tr><td colspan="2">Fire and rescue service considerations
Consider effects of fire (duration and intensity) or firefighting actions (use of jets) on integrity
Consider age and condition of structure</td></tr>
<tr><td colspan="2">References

Association for Specialist Fire Protection (ASFP)</td></tr>
</table>

Passive fire protection

Cavity barriers

Description

Cavity barriers are provided to restrict the spread of smoke and flame within cavities.

General considerations

Cavity barriers should be installed where a cavity would otherwise form a route for smoke and flame spread around an element or elements of construction, to close off the ends of cavities and to limit the size of extensive cavities.

Cavity barriers may be provided around openings through cavity walls for windows or door frames. Window or door frames constructed from steel or timber of the appropriate thickness may close the cavity themselves, thereby not needing an additional cavity closer. However if a window of this type has been replaced during refurbishment with, for example, a UPVC window an effective cavity barrier may need to be added.

Cavity barriers should be constructed so that they are not effected by any movement in the structure due to subsidence, shrinkage or temperature changes, the collapse in a fire of any services penetrating them, failure in a fire of their fixings or failure of any material which they abut, for example a partition wall. Each of these however are possible failures which may allow for unseen smoke spread. It must also be noted that within roof spaces, the members to which cavity barriers may be fitted are not required to be fire resisting for the purpose of supporting the cavity barrier

Figure 26: Cavity barrier

Inherent benefits	**Inherent risks**
Can restrict unseen fire and smoke spread	Failure of cavity barriers can lead to unseen spread of smoke and flame.

Fire and rescue service considerations

- Investigate areas adjacent to known fire compartments for undetected firespread for example, concealed areas, false ceilings or floors and ducting
- Consider the use of thermal imaging cameras

References

Population
Automated building
Description This is a building with automated functions which is not usually occupied by people except for maintenance purposes.

General considerations

Buildings equipped with automated systems are generally warehouses and contain large area open-plan compartments to allow for manoeuvrability of automated systems.

Such buildings may contain automatic fire suppression systems (such as sprinklers), although these systems are likely only to be intended for property protection.

Purpose-built automated buildings may not be designed with life safety as a priority as they are designed to be unoccupied.

Inherent benefits	**Inherent hazards**
If building is not occupied or has a very low number of occupants then it is unlikely that anyone will require rescue. There is more chance of fire engineering solutions having been considered and installed in larger area buildings.	Moving equipment such as cranes and conveyors may present a direct hazard to firefighters and may have the potential to transport burning material around the building and spread fire. In buildings with larger floor area, the seat of the fire may be difficult to locate if there is a lack of ventilation.

Fire and rescue service considerations

- Liaise with the Responsible Person for advice on using any automated systems, only persons competent should operate any systems
- Isolate utilities to machinery, cranes, conveyers, forklift trucks etc., before attempting to gain access
- Consider alternative or defensive firefighting tactics
- Identify and control fire protection systems

References

Population
Awake and familiar
Description This refers to people who should be familiar with a building but who do not ordinarily sleep on the premises (e.g. employees or students).

General considerations	
People in this category would be expected to be familiar with the building and should not be asleep. They should also have received some fire safety training or briefing and most should have experienced evacuation drills. Note that in large buildings or complexes, people may only be familiar with some parts of the building or complex. Also these larger buildings may incorporate extended evacuation strategies.	
Inherent benefits Evacuation should be well planned and rehearsed.	**Inherent hazards** The building may still be evacuating on arrival at the incident, which may hinder entry to the building and hence access to the fire. Occupants of buildings may leave doors open when evacuating which may impact fire growth and spread of smoke and flame.
Fire and rescue service considerations • Confirm with the Responsible Person, or appointed competent person, the evacuation procedures in operation and that all persons are accounted for • Consider potential unexpected fire development or smoke spread due to unexpected actions of occupants	
References BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings Approved Document B	

Population
Awake and unfamiliar
Description This refers to people who are not likely to be familiar with a building and are not likely to be asleep (e.g. shop customers, people in transit).

General considerations

People in this category would be expected to be unfamiliar with the building and will generally not be asleep. They would have received no fire safety training or briefing and would not have experienced evacuation drills

Inherent benefits	**Inherent hazards**
Occupants who are awake and unfamiliar may to respond well to instruction and the fire safety provisions in place to assist with the safe means of escape of building occupants.	Occupants who are awake and unfamiliar are more likely to become lost and require rescue and are more likely to try to exit the building by the same route that they entered whether or not it is the optimum route to safety. Complex evacuation procedures or extended evacuation strategies could cause confusion to unfamiliar occupants e.g. public address systems telling occupants there is a fire and to remain in their area. Occupants may be likely to continue with their pre alarm activities such as eating or shopping which may delay evacuation times into the arrival of the fire and rescue service. Occupants of buildings may leave doors open when evacuating which may impact fire growth and spread of smoke and flame.

Fire and rescue service considerations

- Confirm with the Responsible Person, or appointed competent person, the evacuation procedures in operation and that all persons are accounted for
- Consider potential unexpected fire development or smoke spread due to unexpected actions of occupants

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings.

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Population
Children
Description Children may be present in any environment. There are some issues directly relevant to children in buildings.

General considerations	
Children tend to react differently to fires than adults. In non-domestic environments children will generally be with a responsible adult and will be led by that adult. Where children become separated from familiar adults they may attempt to hide and can do so in small spaces. Where responsible adults become separated from children they may remain inside the building searching for those children, rather than travel directly to a place of safety. Recent studies have shown that sleeping children may not be awoken by fire alarm sounders.	
Inherent benefits	**Inherent hazards** Obstructed staircase (stair gates) Children may be in areas not obvious or accessible to searching firefighters.
Fire and rescue service considerations • Confirm with the Responsible Person, or appointed competent person, the evacuation procedures in operation and that all persons are accounted for • Consider potential unexpected fire development or smoke spread due to unexpected actions of children	
References Summerland disaster (Isle of Man Fire and Rescue Service, 1973)	

Population	
Detained person or prisoner	
Description This refers to people who must not be allowed to escape the custody of officials (such as police officers, prison officers or border agents) and enter the general population.	

General considerations	
People may be detained for a variety of reasons but these are usually for reasons of public order and public safety, or the safety of the detained individual. The requirement to prevent escape means that buildings designed to house detained people will not be designed to allow unescorted evacuation in the event of a fire and will contain locked security doors which may hinder firefighters' access. It also means that the building cannot be immediately and fully evacuated and therefore a progressive evacuation strategy is likely to be employed. Evacuation is likely to be to a secure refuge area rather than outside the building or complex. It is important for fire and rescue services to carry out familiarisation visits and pre-planning exercises with the relevant authorities where possible. In the event of a fire, firefighters will usually be reliant on officials to gain access to and move around within the building. Such officials would also be required to provide security for firefighting operations. It would be expected that the Responsible Person should be on duty in a building used for detention. Buildings used for detention may have been designed to meet the functional objectives of the building regulations through the application of fire safety engineering.	
Inherent benefits	**Inherent hazards**
Enhanced fire protection systems and relatively strict controls on combustible materials should be in place to mitigate the effects of escape prevention measures on life safety in the event of fire.	There is a relatively high risk of violence, deception and unco-operative behaviour from detained people, for example during escape attempts. There is a relatively high risk that detained people may commit acts of vandalism including damaging fire protection, increasing fire loading in particular areas and deliberately starting fires. Escape prevention measures may hinder access for firefighters.
Fire and rescue service considerations • Liaise with the Responsible Person, or appointed competent person, for advice on access and security provisions in the premises, e.g. security doors • Consider violence from detainees	
References	

Population

Extended evacuation strategies

Description

Evacuation strategies in which the total building population is not expected to evacuate the building immediately upon discovery of a fire.

General considerations

These evacuation strategies are likely to be used in larger, more complex and more densely populated buildings where an immediate, total evacuation would be impractical or unsafe:

- Progressive evacuation is the process of evacuating people into an adjoining fire compartment or refuge area, from where they can later evacuate further if required. Progressive evacuation is commonly employed where it is desirable or necessary for the building occupants not to leave the building entirely (e.g. detained people or hospital patients), where the occupants may need assistance to evacuate further (e.g. mobility-impaired people who may not be able to use stairs), or where a significant operational loss would be incurred by the total and immediate evacuation of a large building for a small fire (e.g. large shopping centre).
- Phased evacuation is a strategy in which the people immediately affected by the fire are evacuated first, followed in phases by those likely to be affected next. Where phased evacuation is employed it is common for the means of escape not to have sufficient capacity for the total population to evacuate simultaneously, e.g. building height greater than 30m.
- Two-staged evacuation is a strategy in which staff are alerted to a fire before the general population, so that they may prepare for a stewarded evacuation or investigate the fire and, if necessary, cancel the alarm. Usually, the main alarm will sound if staff confirm the presence of fire, if additional detectors are activated or after a pre-determined time elapses without the alarm being cancelled. Two-staged evacuation is commonly employed where there is a high-density awake and unfamiliar population and a stewarded evacuation is desirable to avoid panic and disorder.

Note that the above strategies are not mutually exclusive and may be used in combination (e.g. progressive evacuation to refuge areas followed by phased evacuation of the refuge areas to a place of ultimate safety). In particular, mobility-impaired and non-ambulant people may be evacuated based on personal emergency evacuation plans (PEEPs), which may involve, for example, evacuation of all mobility-impaired and non-ambulant people in the building to a place of ultimate safety at an early stage.

There is a move to reduce the staff to patient ratio in sheltered accommodation and extra care facilities and this may have an impact on evacuation strategies in these types of premises.

Inherent benefits

Buildings designed for progressive, phased or two-stage evacuation are likely to have greater provision of active and passive fire protection measures to compensate for greater evacuation times.

If effective management is in place, then

Inherent hazards

Extended evacuation times increase the probability that:

- People may become trapped and require rescue, particularly if fire protection measures have been inadequately installed or maintained.

progressive, phased and two-stage evacuations are likely to be more organised and orderly than single-staged, simultaneous evacuation.	• Firefighters entering the building will have to move past large numbers of people moving in the opposite direction.

Fire and rescue service considerations

- Confirm with the Responsible Person, or appointed competent person, the evacuation procedures in operation
- Confirm evacuation status and identify locations evacuated and locations still populated
- Identify other potential access points for firefighting i.e. presence of firefighting shafts consider the impact of firefighting operations on the evacuation
- Keep routes clear from fire and rescue service equipment, to avoid impeding evacuation

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings

Population
Mobility-impaired
Description People with physical, cognitive or sensory impairments affecting their ability to reach a place of safety unaided, but who still have the ability to move under their own power.

General considerations

There are a wide variety of impairments that may affect the ability of a person to reach a place of ultimate safety unaided within the normal movement times used to calculate evacuation times. These include physical impairments which may affect the ability of the person to move to a place of safety (either by impairment to their mobility or dexterity), sensory impairments which may affect the ability of the person to find their way to a place of safety and cognitive impairments which may affect the ability of the person to comprehend what is happening and navigate to a place of safety.

Carers may be able to provide information on the impairments affecting an individual, and management in non-domestic buildings should deal with some issues, for example through the use of personal emergency evacuation plans (PEEPs).

Mobility-impaired people are more likely to require assistance in the event of a fire. There is an increased onus on firefighters to identify building design and condition and protect the structure for a longer time to allow mobility-impaired people to escape or to effect rescued.

Residents with mobility impairments are increasingly living in general housing as opposed to being placed into specialist units and many landlords will not necessarily know if someone has a significant impairment which could affect them in a fire situation; unless it is picked up at sign up. So it is highly likely that buildings may not have been adapted particularly with reference to residential blocks.

A ‘defend in place’ strategy or progressive evacuation strategy is likely to be employed.

A building’s fire telephone, if installed, may be used by people in refuge areas, preventing its use by firefighters.

Lifts (including firefighting lifts and evacuation lifts) may be used as a means of evacuation, particularly for wheelchair users.

Inherent benefits	**Inherent hazards**
Buildings adapted for mobility-impaired people should have relatively good access arrangements.	Possible presence of dangerous or obstructive equipment such as oxygen cylinders (which people may carry with them), mobility scooters and stairlifts. The presence of mobility-impaired people is likely to increase the length of rescue operations and make rescue by firefighters more likely to be required.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to identify personal emergency evacuation plans (PEEPs)

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings

Population	
Permanent resident	
Description A long-term occupant who ordinarily sleeps on the premises.	

General considerations	
A permanent resident of a building is likely to be familiar with that building or believe that they are familiar with that building with regard to fire safety. The Building Regulations cannot control the effects that a permanent resident may have on a building with regard to fire safety. This can range from factors including decorative linings, hoarding, lack of maintenance of smoke alarms and other fire safety provisions. Permanent residents may try to rescue pets, property or family members rather than evacuating the building.	
Inherent benefits Permanent residents should be familiar with part or all of building and its contents and may be able to provide useful information to firefighters.	**Inherent hazards** Residents may be complacent and are not likely to have an escape or evacuation plan. Residents may be asleep and/or intoxicated. Unpredicted or inadvisable DIY carried out by residents may pose a hazard to firefighters. Hoarding or poor housekeeping may present access difficulties, trip hazards and increased fire loading. Occupants of buildings may leave doors open when evacuating which may impact fire growth and spread of smoke and flame. Illegal activity and aggression (including traps) my increase the risks faced by firefighters.
Fire and rescue service considerations • Confirm with the Responsible Person, or appointed competent person, the evacuation procedures in operation and that all persons are accounted for • Consider potential unexpected fire development or smoke spread due to unexpected actions of occupants	
References Approved Document B	

Population
Responsible Person

Description

The Responsible Person may be the employer, owner, landlord or occupier of business or other non-domestic premises.

In Scotland the Responsible Person is called the Duty Holder.

The Responsible Person must by law under the Fire Safety Order:

- Carry out and regularly review a fire risk assessment of the premises
- Tell staff and/or their representatives about the risks identified;
- Put in place, and maintain, adequate and appropriate fire safety measures to remove or reduce the risk to life;
- Plan for an emergency;
- Provide staff information, fire safety instruction and training.

General considerations

A Responsible Person for the building may or may not be in attendance at the time of a fire incident. The Responsible Person may have appointed a competent person (e.g. fire safety adviser) to deal with the fire safety of the premises on their behalf.

The duties of the Responsible Person mean that this person should have an awareness of fire safety within the building and any benefits or hazards present within that building.

Within a shared premises it is likely that there may be more than one Responsible Person. It is therefore important that the fire safety plans for the separate occupants within the building are understood by the opposite parties and work together to provide safe conditions for people within and around the premises.

Inherent benefits	**Inherent hazards**
Good information may be provided on the state of fire safety within the building.	There is a possibility of miscommunication and misleading information being provided by the Responsible Person.

Fire and rescue service considerations

- Establish a clear understanding with the Responsible Person, or the appointed competent person, regarding the priority objectives and the overall tactical plan, consider presence of fire protection features, their status (if operating effectively) and occupants of the building

References

Regulatory Reform (Fire Safety) Order 2005

Regulatory Reform (Fire Safety) Order 2005 Guidance

Population
Security
Description This is any person responsible for the security of a building. This may include airport security staff, prison security staff as well as staff responsible for the security of buildings containing sensitive information.

General considerations

Most buildings will consist of an element of security. In the event of a fire in a high security building, firefighters will usually be reliant on officials to gain access to and move around within the building. Such officials may also be required to provide security for firefighting operations.

Secure buildings may use robust construction which has been tested to relevant security standards (e.g. CPNI/LPS security standards)

Buildings designed for security may have been designed to meet the functional objectives of the building regulations through the application of fire safety engineering.

Inherent benefits	**Inherent hazards**
	Security arrangements may make it difficult for the fire and rescue service to access areas of the building via destructive methods. In the event of a fire, firefighters will usually be reliant on officials to gain access to and move around within the building

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to confirm security arrangements
- Consider alternative access methods.

References

Population
Temporary resident
Description This refers to short-term occupants who sleep on the premises but are not likely to be familiar with the building (e.g. hotel guests)

General considerations

Temporary residents are likely to be unfamiliar with the building and in contrast to awake and unfamiliar occupants, temporary residents may be asleep.

Inherent benefits	**Inherent hazards**
Temporary residents may not have become complacent over time due to previous false alarms or over familiarity.	Residents may be asleep and/or intoxicated. Occupants who are unfamiliar with the building are more likely to become lost and require rescue, and are more likely to try to exit the building by the same route that they entered whether or not it is the optimum route to safety. Complex evacuation procedures or extended evacuated strategies could cause confusion to unfamiliar occupants e.g. public address systems telling occupants there is a fire and to remain in their area. Occupants of buildings may leave doors open when evacuating which may impact fire growth and spread of smoke and flame.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to confirm the evacuation strategy and current incident status

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings

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Population
Non-ambulant
Description People who are unable to move without assistance e.g. person confined to bed.

General considerations

In the event of a fire, non-ambulant people are likely to be reliant on carers with a personal emergency evacuation plan (PEEP). This may involve the use of 'defend in place' or progressive evacuation strategies. Some non-ambulant people may be connected to large amounts of medical equipment and this may increase evacuation times. It is also possible that moving some non-ambulant people may be fatal to them.

However, sheltered accommodation now houses a number of people who are supported in their own homes with only support visits during the day but may be bedridden. Carers may not be available to assist with evacuation and this should be considered by the fire and rescue service.

Lifts (including firefighting lifts and evacuation lifts) may be used as a means of evacuation.

Inherent benefits	**Inherent hazards**
Buildings that have been specifically designed or adapted for non-ambulant people should have relatively good access arrangements due to the requirement to move people in beds or with medical equipment attached to them.	Where a non-ambulant person is found in a building that has not been specifically designed or adapted for them, evacuation or rescue may be difficult to achieve without causing harm to the non-ambulant person. Medical equipment connected to non-ambulant people may be dangerous or obstructive. Piped oxygen or oxygen from cylinders may increase the severity of the fire and there is also a risk that oxygen cylinders will explode. The presence of non-ambulant people is likely to increase the length of rescue operations.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to identify personal emergency evacuation plans (PEEPs)
- Consider defend in place strategy where evacuation is not practical or possible

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings

Crowder, D and Charters, D. Evacuating vulnerable and dependent people from buildings in an emergency. BRE Press, 2013

Smoke control
Mechanical smoke control
Description Powered systems used to control or remove smoke from a building, allowing low-level escape routes to be kept clear of smoke, facilitating firefighting activities and reducing damage to the building and its contents.

General considerations

A mechanical smoke control system will comprise of a minimum of 2 fans of specified performance. The system may also include ductwork, smoke shafts, automatic opening vents and dampers to prevent the syphoning of smoke from its intended passageway into unwanted areas potentially unseen.

Figure 27: Smoke control system

Mechanical smoke control may be operated manually by the fire and rescue service upon arrival if the objective of that system is solely to assist in firefighting operations. It is therefore important that the fire and rescue service gain an understanding of the functional requirements of the system within the building in question and how to use that system to their advantage within a given fire scenario.

The design objectives of the system may also include:

- smoke temperature control (for example to maintain gas temperatures within the fire performance envelope of a glass façade within an atrium in order to allow for phased evacuation from higher levels);
- means of escape protection (where it is essential that the system comes into operation as soon as possible during the fire, usually automatically upon receipt of a signal from a smoke detection system);
- and property protection (which may aim to keep the smoke layer above sensitive materials or aim to maintain the smoke layer below a critical temperature)

Figure 28: Smoke control system

Automatic opening vents are often placed on the roof of the building and need to be able to withstand potential wind loads, snow loads, should be operable at low ambient temperatures and have tested reliability with respect to operating cycles.

Inherent benefits	**Inherent hazards**
The presence of mechanical smoke control may provide an environment within which only sprinkler heads in the area required to control the fire are activated.	Potential for unseen or unintended spread of smoke if the system is not adequately designed or maintained. A mechanical smoke control system may only be designed for life safety purposes, therefore providing conditions for the safe evacuation of occupants, but expected to become overwhelmed

	by the time of firefighter intervention.

Fire and rescue service considerations

- Liaise with the Responsible Person who will ensure only a competent person operates any integrated ventilation system
- Consider the potential for build-up of combustible materials in older installations
- Consider the use of thermal imaging cameras to detect hidden firespread

References

Morgan, H.P, Ghosh, B.K, Garrad, G. Design methodologies for smoke and heat exhaust ventilation, BR368. BRE Press, 1999

Smoke control
Pressurisation systems
Description Pressurisation systems protect escape routes and firefighting shafts against the ingress of smoke by maintaining the pressure within the escape route higher than that in the adjacent spaces.

General considerations

Pressurisation systems rely on maintaining a differential pressure between adjacent spaces.

Pressurisation systems may be encountered within escape stairways and corridors, firefighting shafts serving basements at a level greater than 10m below ground level or floors at a height greater than 30m above ground level.

Design guidance recommends that a pressure differential between adjacent spaces within a pressurisation system should be 50 Pascals.

The system should comprise of inlet fans, ductwork and outlet grills in order to distribute the air to exactly where it is needed. Pressure relief dampers should release excess air or pressure build-up within a space where the doors are closed. Automatic air release should also prevent any pressure build up in adjacent spaces and may come in the form of automatic vents, natural shafts, mechanical extract systems or even utilise the natural air leakage of the building.

It may be difficult for the system to maintain this pressure difference when trying to overcome buoyancy pressure created by the hot smoke layer, expansion of gases in the compartment due to heating and the effects of stack and wind pressure. Doors being opened during firefighting activities may also affect the pressure differentials between adjacent spaces however the system should be designed to cope with these effects.

Insufficient pressure differences across a closed door may allow for smoke ingress into the protected area, whilst excess pressure differences may impede the operation of the door during firefighting activities.

These may be caused by a change in the leakage rates of the building, poor maintenance or blockage of the automatic air release mechanism.

Inherent benefits	**Inherent hazards**
A pressurisation system is less likely to be affected by adverse wind pressure conditions than a natural smoke control system.	Doors may become difficult to operate due to excessive pressure differentials across the doorway.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to confirm successful operation of system
- Investigate for unexpected smoke travel

References

Smoke control
Smoke curtains
Description Smoke curtains prevent the movement of smoke and heat from one area to another during a fire by channelling or containing the smoke and heat

General considerations

Smoke curtains are often deployed as a part of a fire engineered design for smoke control within a building and are often utilised within large spaces or areas which are designed to be open plan but require means to prevent the early ingress of smoke to areas not immediately affected by the fire. They may be fixed or deployable in nature and act to channel or contain smoke and heat.

Smoke curtains rely on the buoyancy of hot smoke in order to contain this smoke within defined areas often allowing for greater periods of tenable conditions for firefighters as well as increased available egress time for occupants.

Gas cooling during firefighting operations may eliminate the designed function of the smoke curtain as the smoke loses buoyancy and travels beyond the curtain.

Inherent benefits	**Inherent hazards**
Contain or channel smoke during a fire.	Deployable smoke curtains may jam or be sucked out of place by extraction fans. Smoke may not remain in the intended area if it is cooled, for example by firefighting activity.

Fire and rescue service considerations

- Identify the successful deployment of smoke curtains
- Use direct firefighting techniques where possible as opposed to gas cooling
- Consider alternative ventilation and firefighting strategies
- If the fire development exceeds the predicted fire size smoke curtains may not be effective

References

BS 9999:2008 – Code of practice for fire safety in the design, management and use of buildings.

Smoke control

Car parks

Description

Car parks may be considered as either open sided or enclosed.

An open sided car park should have no basement stories. Natural ventilation should be provided by permanent openings at each level with a venting area of at least 1/20th of the floor area at that level of which at least half should be provided between two opposing walls. If this criteria is not met then the car park may be regarded as enclosed.

General considerations

Natural smoke ventilation may be provided to enclosed car parks which should consist of an aggregate free vent area of not less than 1/40th of the corresponding floor area. Half of this area should be split equally between two opposing walls (1/160th on each side).

Mechanical ventilation may be provided in enclosed car parks where the above cannot be achieved. Such a system should provide for at least 10 air changes per hour within a fire condition and consist of 2 parts which are capable of running independently and or together, each capable of extracting 5 air changes per hour. Extract points should also be provided with 50% at low level and 50% at high level.

Impulse jet fans may be installed within the car park. These are intended to direct any smoke towards the extract points. The activation of the impulse jets may be delayed in order to ensure that occupants means of escape is not compromised by the action of the impulse fan system.

Car park ventilation systems are likely to be effective during the early stages of a car fire, but may become overwhelmed if the fire spreads to involve multiple cars, as the size of the fire and quantity of smoke production will increase rapidly.

Inherent benefits	Inherent hazards
Many car parks will have good inherent natural ventilation	Similarity to basements

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, for advice on fire engineered strategies

References

Morgan, H.P, Ghosh, B.K, Garrad, G. Design methodologies for smoke and heat exhaust ventilation, BR368. BRE Press, 1999

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

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DCLG Car Parks report

Structural elements
Air supported structures
Description – A type of structure consisting of a membrane anchored to the ground and kept in tension by internal air pressure.

General considerations

There are two main types of air-supported structure:

- Structures which consist of inflated, above atmospheric pressure, double membranes that form structural elements, such as columns, beams or domes. These types of structures do not pressurise the accommodation space within the inflated structure.
- Structures which consist of a single membrane supported by an internal pressure above atmospheric pressure. For these types of structures the internal accommodation space is pressurised and anyone within this space will be subject to this increased pressure.

Both types are supported by air pressure and a fire can burn a hole in the membrane which can result in a potentially sudden reduction in air pressure. This can result in collapse of the structure.

Inherent benefits	**Inherent hazards**
Air supported structures are easy to identify. The membrane will normally melt or burn away during a fire, forming a hole to the outside. The membrane material itself should not burn significantly further and the fire will ventilate itself.	Fire burning through the membrane may cause the air supported structure to collapse due to the resulting drop in air pressure.

Fire and rescue service considerations

- Identify type of air supported structure
- Consider early collapse of structure may occur if fire burns through membrane
- Consider defensive firefighting tactics

References

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001 – chapter 7.19, pp125-126

BS 6661:1986 - Guide for design, construction and maintenance of single-skin air supported structures (withdrawn but referenced in the Fire Service Manual)

Structural elements
Arches
Description An arch is a means of supporting a load across a space between two points. Arches transmit loads under compression.

General considerations

Arches can be formed of blockwork, concrete, stone or steel. Arches work by transmitting loads through the compression of the materials making up the arch.

Issues relating to arches are generally similar to beams and will be dependent upon the nature of the material of which they are constructed. However, whereas the upper surface of a beam is under compression and the underside is under tension, all of the principal components of an arch should be under compression.

Figure 29: An arch

Inherent benefits	**Inherent hazards**
Arches are easy to identify. There should be clear signs or symptoms of failure and therefore clear signs of potential collapse.	Failure of arches will depend on the material of which they are composed and as such there is the possibility for rapid collapse if exposed to fire.

Fire and rescue service considerations

- Consider effects of fire (duration and intensity) or firefighting actions (use of jets) on integrity.
- Consider age and condition
- Consider potential effects of arch failure on structure
- Monitor for signs of cracking or spalling and potential failure
- Consider seeking advice from structural engineer

References

Structural elements
Beams
Description – A beam is an element commonly incorporated in the structure of a building to support (or transfer) an applied load to other structural elements. Beams commonly transfer floor loads horizontally into columns.

General considerations

Simple beams transfer load in a horizontal direction between two supports, commonly columns. Other types of beam may extend this concept over a number of supports, but the general concept applies to all. Their upper surface is under compression whilst the lower surface is under tension.

Within the built environment beams commonly consist of either concrete, steel or timber. In multi-storey buildings, beams usually support floors. These are most commonly concrete but floors of other materials, such as timber, are sometimes used. The most common type of floor used in multi-storey construction in the UK utilises a composite metal deck; the steel beam supports a metal deck onto which the concrete floor is poured.

It can be considered that all beams are load bearing, however not all beams are designated as elements of structure. The most common exceptions are beams in single-storey buildings and beams only supporting roofs. Where beams are considered an element of structure they will have a designated period of fire resistance associated to them this is commonly dependent upon the building height, building use or building complexity.

Beams are designed to fail in a ductile manner at ambient temperature and should also do so at elevated temperatures that are consistent with compartment fires. As such there should be signs, including deflection or localised material failure, that the beam is about to fail. Beam failure will necessarily result in the load it is supporting being allowed to collapse. However, beams may fail in a non-ductile manner.

Beam failure is not as critical as column failure as it will commonly be a localised failure and less likely to impact upon the entire building.

Inherent benefits	**Inherent hazards**
There should be clear signs or symptoms of ductile failure and therefore clear signs of potential collapse. These include deflection and localised material failure.	Beams may fail in a non-ductile manner. This means a potential for sudden collapse of a beam that otherwise appears safe. Recent research has shown that some buildings are susceptible to localised failure in the cooling period after fire and it should not be assumed that a building is safe during that period.

Fire and rescue service considerations

- Consider the use of thermal image cameras to assess temperatures
- Consider potential effects of beam failure on structure
- Monitor for signs of deflections or distortions in floors, indicating potential failure
- Be aware that smoke may conceal signs of deflection or potential failure

- Consider water cooling of affected beams to prevent collapse – tactics should be considered taking into account material properties
- Consider seeking advice from structural engineer

References

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001 – Chapter 5

Structural elements
Columns
Description A column is an element commonly incorporated in the structure of a building to transfer loads in a vertical direction through compression.

General considerations

Columns transfer loads in a vertical direction. They generally transfer the load from a floor, beam or roof structure into the ground. They may also support arches. Columns transfer the load they are supporting simply through compression of the material they are made of.

Within the built environment columns commonly consist of either concrete, masonry, steel, cast iron or timber. By far the most common in non-domestic buildings are steel and concrete Sometimes one of these materials will be encased in another, such as steel within concrete. However, most steel columns are protected in a proprietary material such as boards or an intumescent coating. The strength of a column is reliant upon the compressive strength of its material component.

All columns can be considered to be load bearing and will invariably play a critical role in the overall structure of the building. Failure of a column is likely to result in one or a number of other structural elements failing, particularly those listed above. Failure of one column may also result in more of the overall load of the building being transferred to other columns, which may lead to sudden or premature failure of other columns.

Failure of a column tends to occur through either crush failure or buckling of the column. However the stability of a column is greatly increased if (and dependent upon) it being restrained top and bottom. Any loading applied other than vertically with greatly increase the stress on the column which may lead to collapse depending upon the rigidity of its supports. Such loading and collapse may occur as a result of expansion of beams or floors pushing outwards on the column, or may be a result of some other part of the building collapsing and pulling in on the column.

Inherent benefits	**Inherent hazards**
Exposed columns can be easily monitored for attack by fire.	A reduction in column cross section or material strength through fire attack can lead to serious structural failure. There is a potential for columns not directly affected by fire to be affected by failures in other areas due to the redistribution of loads.

Fire and rescue service considerations

- Utilise thermal image cameras to assess temperatures
- Consider potential effects of column failure on structure
- Monitor for signs of spalling or potential failure
- Consider water cooling of affected columns to prevent collapse
- Consider seeking advice from structural engineer

References

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Structural elements
Connections
Description Connections are a means of transferring load from one structural element to another. The connection may be rigid or flexible.

General considerations

Connections may be in the form of steel joist hangers, steel nail plates connecting truss members, steel truss clips and end plates. Timber connections such as mortise and tenon connections and pin joints are likely to be in use within more historic buildings.

Figure 30: Connections

Modern connections do not have a defined period of fire resistance like their relevant structural members. It may be likely, therefore, that connections will behave differently in fire to the structural elements which they connect. The structural elements which they connect may also differ in material. For example steel columns connected to concrete foundations or steel beams connected to masonry or concrete walls.

Figure 31: Connections

Resin anchors, used in connecting steel structural elements to masonry and concrete are also known to prematurely soften and weaken when exposed to fire.

Figure 32: Factory built timber trusses with steel nail plates

In the case of steel nail plates used to connect factory built timber trusses, these are known to heat up and char the timber causing them to fall out. This may lead to structural collapse of the trussed roof but it is likely there will be few or no signs and symptoms of imminent collapse.

Inherent benefits	**Inherent hazards**
Connections may provide for a redistribution of load in a fire.	Structural members such as beams may try to move due to thermal expansion but rigid connections will not allow significant movement. This can result in the beam or connections failing prematurely during heating or cooling. Failures leading to non-structural and or structural collapse are more likely to occur during cooling. This could be after firefighter actions

	but during a period that firefighters may still be in the building. Connections particularly within more historic buildings may no longer be distributing their originally designed load. Connections may indeed be floating which may lead to immediate collapse within a fire scenario.

Fire and rescue service considerations

- Consideration should be given to the type and condition of connections
- Identify type of construction i.e. modern or historic
- Utilise thermal image cameras to assess temperatures
- Consider potential effects of connection failure on structure
- Monitor for signs of failure
- Consider water cooling to prevent collapse
- Consider seeking advice from structural engineer

References

Ogden, R.G and Henley, R. Connections between steel and other materials – Interfaces. The Steel Construction Institute, 1996

Structural elements

Floors

Description – A floor is a composite system consisting of load bearing elements.

A floor system can also include:

- The upper surface or finish of the floor
- The lower surface of the ceiling of the compartment below
- Beams transferring the load of the system to the columns or load bearing walls that support the floor

General considerations

Floors may be simply formed by a series of wide, shallow beams, and therefore behave as such. However, invariably they are composite structures which incorporate a number of components all acting together.

Floors may also be constructed from beams or joists acting as the load bearing members with a skin or boarding over the joists and a ceiling (often plaster or plasterboard) below. The specific materials used and construction (in particular the ceiling materials and beams) will impact on the fire resistance of the floor system.

A floor may be load bearing or a false floor. This is sometimes difficult to identify and could create a cavity, typically these are used for passage of cables. False floors may become spongy underfoot if they are significantly damaged by fire but this does not necessarily mean any impact on the loadbearing capacity of the floor. However, it should be considered that any floor is a loadbearing floor unless it can be determined otherwise.

Floor systems are unlikely to fail as a complete system all at once; there will generally be an initial failure at one point. This may result in redistribution of load throughout the floor system but may also impose additional or lateral loads on supporting walls and columns. Floors constructed as a composite system may also contribute to hidden firespread throughout the building.

Collapse of a structural floor within a building is likely to lead to partial structural collapse elsewhere in the building, particularly where the floor supports other structural elements which then support additional load above.

Ground floor flooring may be floating and constructed in a similar way to the floors above, particularly in domestic dwellings where services and insulation may also be installed.

Inherent benefits	**Inherent hazards**
There should be clear signs or symptoms that the floor is deflecting and therefore clear signs of potential collapse.	Identification of Load bearing floors or false floors can be difficult. The load bearing structure can be hidden by raised floors therefore making it difficult to see signs and symptoms of collapse. The gaps between parallel joists produce cavities which provide a means for smoke and fire to travel throughout the structure, particularly in hearth

	fires. Connections and the junctions between floors and walls may provide paths for fire and smoke spread from wall cavities into floor cavities and vice versa.

Fire and rescue service considerations

- Consideration should be made to the type and condition of floors involved in fire
- Potential collapse of floors may lead to subsequent collapse of other parts of the structure
- Any floor involved in fire should be investigated for stability and potential undetected firespread
- Consider use of thermal image camera to identify hidden firespread

References

Structural elements
Load bearing walls
Description – A load bearing wall is a structural element commonly incorporated in the structure of a building to transfer loads in a vertical direction through compression, similar to a column.

General considerations

Load bearing walls transfer loads in a vertical direction. They generally transfer the load from a floor, beam or roof structure into the ground. Load bearing walls transfer the load they are supporting simply through compression of the material they are made of and are similar in their basic concept to a column.

Within the built environment load bearing walls commonly consist of either concrete, masonry, steel, or timber. Composite products may also be used, such as structural insulating panel systems (SIPS). However, the external finish of a load bearing wall may conceal its actual load bearing structure (e.g. plaster, over-cladding or non-load bearing brickwork). The strength of a load bearing wall is reliant upon the compressive strength of its load bearing component.

Any wall may be load bearing or non-load bearing. There is no easy way to identify this. The assumption should be made that all walls you see are load bearing unless it can be established otherwise.

Failure of a load bearing wall is likely to result in one or a number of other structural elements failing, particularly those listed above. Failure of part or all of a load bearing column may also result in more of the overall load of the building being transferred to other load bearing walls or parts of wall, which may lead to sudden or premature failure of the remainder of the structure.

Failure of a load bearing wall tends to occur through bowing and buckling of the wall. However the stability of a load bearing wall is greatly increased if (and dependent upon) it being restrained top and bottom across the length of the wall (i.e. walls invariably fail to one side or another, not towards their end). Any loading applied across the wall will greatly increase stress which may lead to collapse depending upon the rigidity of its supports and or interaction with other structural elements.

Maximum resistance to collapse from lateral loads will therefore occur at the intersection between two walls. Such loading and collapse may occur as a result of expansion of beams or floors pushing outwards on the load bearing wall, or may be a result of some other part of the building collapsing and pulling in on the wall. Thermal bowing (induced by and generally towards the fire) can also occur if the load bearing wall is fixed top and bottom and subjected to elevated temperatures.

Load bearing walls may also contain cavities or combustible insulation, through which hidden firespread can propagate and attack the load bearing materials within the wall unseen.

Inherent benefits	**Inherent hazards**
There are often clear signs and symptoms of collapse such as cracks and distortion.	A reduction in material strength through fire attack or collapse as a result of lateral loads can lead to serious structural failure. There is a potential for walls not directly affected by fire to be affected by failures in other areas due to the re-distribution of loads. Load bearing walls are difficult to identify and may

be either external or internal to the building.

Hidden firespread can occur within a load bearing wall unseen, attacking the structural component and leading to collapse.

Cold-form studs used within load bearing walls present the possibility of immediate failure with no warning often due to the weak nature of the connections used in their construction.

Lightweight timber studs used within load bearing walls may fail suddenly if fire is able to propagate within the wall. Good workmanship can negate this problem, but any evidence of poor workmanship or fire spreading unseen (smoke issuing) should lead to further investigation by opening up the wall.

Beams built into masonry walls can promote failure outwards of a load bearing wall due to the thermal expansion of the beam.

Collapsing joists which are built into the wall will provide a levering action and potential collapse of the wall.

Temperature differences between the fire side of a load bearing wall and the non-fire side can reach up to 500°C. This can cause the wall to bend and potentially collapse.

Fire and rescue service considerations

- Consider the condition of walls involved
- Walls involved in fire should be investigated as to their structural integrity, modern walls may be built around timber frames and if fire has penetrated the cladding a more serious failure may be imminent due to undetected firespread.
- Consider potential of secondary collapse
- Consider seeking advice from structural engineer

References

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Structural elements
Lintels
Description - A lintel is a load bearing horizontal member which spans an opening between two vertical supports. These are generally found above portals, doors, windows and fireplaces.

General considerations

Lintels are a type of beam and generally behave similarly to other types of beam. Their upper surface is under compression and their lower surface is under tension. Lintels are usually constructed of concrete, steel or timber, although they may also be constructed of composites.

Because they are found above openings, lintels are often exposed to flames exiting the building through openings. This can lead to the failure of a lintel and a collapse of the load that it supports. However, failure of a lintel is likely to cause localised structural damage rather than a complete structural collapse, and therefore lintel failure is not usually as critical as failure of a beam or column.

Figure 33: Lintel

Inherent benefits	**Inherent hazards**
Lintels should be easy to identify and the space beneath undamaged lintels can offer a place of relative safety for firefighters. There should be clear signs or symptoms of ductile failure and therefore clear signs of potential collapse.	There is potential for concrete lintels to explode under severe temperatures. Failure of a lintel may lead to localised collapse of walls above opening or in some circumstances entire walls, e.g. where the lintel is over a large opening

Fire and rescue service considerations

- Consider potential of localised or secondary collapse
- Consider alternative access to avoid potentially weakened lintels
- Consider seeking advice from structural engineer

References

Gordon, J.E. Structures: Or Why Things Don't Fall Down, 2003

ICE Manual of Structural Design: Buildings, 2012

Davison, B and Owens, G.W (editors), Steel Designers' Manual (7th Edition). SCI (Steel Construction Institute), 2012

Structural elements

Trusses

Description

Trusses are a collection of members and connections that work as a system under a combination of tension and compression.

General considerations

As a collection of members and connections that work as a system there is an increased reliance on connections.

Roof trusses support the wind loads of the building and support the roof tiles. The image shown is typical of a truss in a leisure or commercial building. These are used where it is necessary to achieve long, clear spans. They are most commonly used to support roofs but are occasionally found supporting internal floors.

Figure 34: Trusses

In modern domestic buildings, trusses may consist of lightweight thin section traditional timber members connected by steel nail plate connections. These members spread the load of the roof to the walls and are connected to the wall plates by steel truss clips.

Older buildings may include large timber rafter design.

Larger building trusses may include the use of laminated timber, steel girders or wrought iron.

Inherent benefits	Inherent hazards
Benefits are reliant upon the materials used within the truss system. Pre-fabrication should lead to better quality control and a more consistent product.	The structural economy of a truss system allows for the minimum amount of material to be used, however the performance of all materials when exposed to fire decreases with size. If one member fails within a fire this can compromise the integrity of the whole truss system. Where trusses are tied in together in order to strengthen against wind loads, the failure of one truss may lead to multiple failures at a distance from the initial failure point. Truss failure may cause non-structural collapse of load bearing walls where the trusses are tied in to the wall.

Fire and rescue service considerations

- Consideration should be made to the type and condition of trusses particularly if they have been involved in fire.

- Consider potential of secondary or localised collapse
- Consider potential effects of structures supporting decorative features i.e. false chimneys and sources of renewable energy
- Consider seeking advice from structural engineers

Further reading

Southline Steel Industries - Introduction to Steel Roof Trusses

Structural frame
Masonry
Description Masonry consists of individual units laid in and bound together by mortar and can be used to construct the structural frame of the building. Masonry is unlikely to be the sole material used in a building structure as other materials are required for certain aspects, e.g. floors.

<table>
<tr><td colspan="2">General considerations

Masonry units are likely to consist of brick, stone, marble, granite, limestone or concrete block.

Masonry may be used in the construction of arches, beams and columns, the structural integrity and performance in fire of which may depend greatly on the quality of mortar and workmanship used.

Buildings are likely to be clad in mortar due to its aesthetic appearance and may therefore in fact consist of a timber or concrete structural frame beneath.

Even where masonry is used as the load bearing material in walls other materials will normally be required for the construction of floors.</td></tr>
<tr><td>Inherent benefits

Mortar has a good Inherent fire resistance (quite possible to achieve periods of fire resistance of up to 4 hours).

Some aerated blocks (autoclaved) may be heat treated providing improved performance in fire.</td><td>Inherent hazards

Older concrete (clinker) can have a high carbon content and can result in concrete “burning” and lead to structural collapse. (Appearance of un-burnt coal).

Mortar becomes friable and blocks can become loose. Later stages of fire, even after extinguished, can lead to collapse.

Performance properties of masonry are highly dependent upon workmanship and quality of mortar.</td></tr>
<tr><td colspan="2">Fire and rescue service considerations

• Consider potential and impact of collapse
• Consider age, condition and workmanship</td></tr>
<tr><td colspan="2">References</td></tr>
</table>

Structural frame

Steel

Description

Structural steel may be in the form of

- Hot rolled steel
- Cold rolled steel
- Cellular steel

Each may be used in the production of steel frame structures, either separately or in combination with the other forms of steel or other structural materials.

General considerations

Steel frame buildings are defined by the majority of their load bearing structure comprising of steel. In typical steel frame construction the load of the floors and cladding is carried at each level by steel beams which in turn transfer the load to the steel columns.

The fire resistance of steel is a function of its mass; the thicker the gauge of steel, the longer it will take for its temperature to increase. Steel will rapidly lose strength and stiffness at high temperatures (>550°C) causing deformation and possible collapse therefore it should be assumed that after flashover, unprotected steel is weakening and is susceptible to complete collapse.

Figure 35: Steel framed structure

Steel will also expand with increasing temperature. As an example a 10m long steel joist will expand by 60mm under a 500°C rise in temperature.

The way in which structural steelwork reacts to sustained elevated temperatures created within a fire means that the majority of steel frame construction will require fire protection. This may be solid and achieved by the encasement of concrete, the use of fire resisting boards, the application of intumescent paint or the spraying of mineral fibre etc. This may also be hollow, for example the encasement of steelwork within fire resisting boards. Each means that steelwork is often covered up, hard to see and susceptible to experiencing concealed firespread.

Inherent benefits

The behaviour of steel is predictable

Steel is non-combustible and presents no inherent risk of firespread from direct burning.

Inherent hazards

Heat transfer through thermal conduction can add to the effects of firespread throughout the building.

Steel will lose strength and stiffness at relatively low temperatures (>550°C) in relation to compartment fire development causing deformation and possible collapse therefore it should be assumed that after flashover, steel is weakening and is susceptible to

	complete collapse. Steel may be hidden and difficult to identify within the building. Unseen damage to the fire protection of steelwork may have implications on firespread and structural collapse elsewhere in the building.

Fire and rescue service considerations

- Consider defensive fire firefighting techniques due to potential early collapse
- Identify whether steel has been protected from effects of fire by cladding and condition of cladding
- Consider the length of time and to what temperature the steel has been subjected to
- Consider the use of thermal imaging cameras
- Monitor adjacent compartments or structures for conducted heat transfer

References

Structural frame
Timber
Description Timber used in the structural framework of the building. Types of timber may include historic timber, traditional timber, engineered timber joists or laminated veneer lumber.

General considerations

Timber is a combustible material, however its properties vary greatly even within a given species based upon grain direction and impurities within the timber such as knots and shakes.

Solid structural timber is generally used for beams up to 100mm in width and columns of 150mm square. Laminated timber is generally adopted over greater sizes. Timber is also commonly used in roof construction and can vary greatly in size and quantity based upon roof design.

It is important to note that a building may be timber framed even though it does not appear so.

The materials used in conjunction with a timber frame building such as masonry, steel and cement will have an effect on the overall structural performance of the timber frame building structure.

Inherent benefits	**Inherent hazards**
Timber sizes used in construction are not easily ignitable. 'Sacrificial' timber will have been built into the construction Burning and charring rate is predictable and this charring of sacrificial timber may then act as a form of insulation against further damage from fire.	Timber burns and during this time it will lose its inherent strength in proportion to its decrease in cross sectional area which may lead to structural collapse: • Historic timber tends to have a large cross section and will undergo a steady failure; there will be warning signs before collapse • Modern engineered and/or lightweight timber tends to have a small cross section and be reliant on other fire protection. Direct fire attack on the timber may result in relatively rapid failure. Burning timber may contribute to the spread of fire within the structural. This spread of fire may be unseen behind the outer skin of the building.

Fire and rescue service considerations

- Consider the presence of concealed spaces and potential for undetected firespread
- Consider effects of fire (duration and intensity)
- Consider age and condition

References

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Structural frame
Demountable structures
Description Demountable structures are designed to be rapidly erected and dismantled many times. These can be temporary structures (<30 days) or more "permanent" structures.

General considerations

Demountable structures may provide shelter (tents or marquees), platforms and supports for performers (stages), viewing facilities (temporary seating or grandstands) and media facilities (support for floodlights etc.).

The structural components are generally required to be lightweight, rapidly assembled, readily demountable and reusable. These structures are usually assembled from readily connected components.

Demountable structures often use steel uprights (or columns) fitted with steel baseplates (see connections) which often sit onto timber spreaders as foundations. The use of ground anchors is also popular although this is dependent upon the nature of the ground. It is not uncommon for scaffolding to be used as the structure otherwise the components are prefabricated.

Tents and marquees will be covered by a flexible material by mechanical means such as beams, columns, poles, arches, ropes and/or cables. The covering material used should not contribute to the fire and should be free of flaming molten droplet characteristics and should not readily support combustion.

The structural members of demountable structures are commonly steel, aluminium or a hybrid of steel and aluminium.

The roofs of some demountable structures may be supported within substructures such as stage floors and these areas may be susceptible to unseen firespread leaving the roof structure exposed to fire which may cause collapse of the roof.

These structures may not be subject to control under Building Regulations.

Inherent benefits	Inherent hazards
Easily identifiable. Spread of fire from tent (or marquee) to tent is down to contents and the fabric of the tents should not contribute to firespread.	Structures may not have been subject to Building Regulations and may not have the expected fire resistance of other buildings. The frame of these structures may be exposed and unprotected from fire. If affected by fire the structural frame may buckle and could collapse without warning. Aluminium has a low melting point (pure aluminium melts at 660°C) and will rapidly lose its strength when exposed to fire. Voids under stages can provide a route for undetected firespread. Some structural elements may be hidden under

	staging and be affected by undetected firespread. Setting up "tent cities" may not consider building separations as required by Building Regulations which can present issues with firespread.

Fire and rescue service considerations

- Consider potential for rapid structural failure

References

Temporary demountable structures. Guidance on procurement, design and use. Third edition. The Institution of Structural Engineers, 2007.

Safe Use and Operation of Temporary Demountable Fabric Structures. MUTAmarq, 2013.

Structural frame	
Modules	
Description Modules are a collection of beams, columns , floors and connections which are pre-assembled and joined together on site.	

General considerations	
Modules are pre-fabricated sections of a building that are joined together on site to produce a complete building. Each module will contain structural elements such as beams, columns, floors and the connections between them, and will be connected to adjacent modules. Individual modules are usually robust and should have undergone quality control and testing (including fire testing) as a completed unit. Therefore, weaknesses in a modular structure are usually found in how they are joined together with other modules on site. It should also be noted that only individual modules are likely to have been tested, not multiple modules joined together.	
Inherent benefits Modules are constructed with high quality control due to their factory assembly. Individual modules exhibit an inherent robustness.	**Inherent hazards** Undetected firespread within cavities may be likely due to the difficulties inherent with the installation of fire stopping between modules. It may be difficult to identify what materials modules are constructed from.
Fire and rescue service considerations • Monitor all adjacent compartments for firespread • Consider the use of thermal imaging cameras	
References ABI Report, Terry Day Modern methods of house construction: a surveyors guide, BRE Trust, 2005	

Structural frame
Portal or rigid frame
Description Series of load bearing structural frames formed of beams and columns joined together using rigid connections.

General considerations	
A portal or rigid frame is usually constructed of steel but can be constructed of pre-cast concrete or structural timber composites. The latter are usually seen in retail buildings. Most portal frames are single storey buildings although increasingly, modern portal frame buildings will have internal mezzanine floors for offices or storage. The columns and roof members are joined with rigid connections which have the effect of passing the roof loading to the rest of the structure. The structure will consist of little or no internal bracing, whilst the roof would be supported on a series of purlins allowing for large unencumbered storage and working areas. Portal or rigid frame construction is designed for inward collapse within the UK and a basic single storey structure may be expected to collapse within 30 minutes within a fully developed fire. Such buildings are not usually fire protected unless there are other buildings nearby and firespread must be prevented. In this situation, the walls and columns along the affected sides of the building are protected and are less likely to collapse in the early stages of a fire.	
Inherent benefits Known that the building will collapse inwards.	**Inherent risks** Rapid collapse inwards.
Fire and rescue service considerations • Consider potential for rapid structural failure	
References	

Structural materials
Blockwork

Description

Blockwork or masonry is an assembly of discrete pieces or units of natural stone, clay, concrete, red brick, calcium silicate or gypsum which are stabilised and sealed with mortar. The mortar is an inorganic setting mastic, usually containing sand and a hydraulic binder.

General considerations

Blockwork can be used for load bearing walls and non-load bearing walls, but it is not limited to walls. Blockwork can also be used for columns, arches and cladding systems. It is mostly inherently non-combustible and provides good fire resistance.

Clay or concrete blocks have similar fire behaviour.

Blockwork can undergo thermal bowing which can lead to structural collapse.

Figure 36: Blockwork

Inherent benefits	**Inherent hazards**
Blockwork is mostly non-combustible and provides good fire resistance. Lightweight autoclaved aerated concrete blocks perform well in fire.	Breezeblock walls may be combustible due to presence of carbon materials (e.g. coal clinker or reclaimed or recycled materials from fly ash or bottom ash). Look for appearance of unburned coal in blockwork. There is the possibility for transfer of combustion products (e.g. CO) through porous blockwork, which may be hazardous to people in other parts of the building and lead to misidentification of fire location. Mortar may become friable and weaken a wall in later stages of fire or after fire.

Fire and rescue service considerations

- Consider potential for collapse
- Investigate adjoining compartments for spread of products of combustion

References

de Vekey, R. Structural fire engineering design: materials behaviour – masonry. BRE, 2004.

Cooke, G.M.E and Morgan, P.B.E. BRE Information Paper (IP21/88). Thermal bowing in fire and how it affects building design, BRE, 1988.

Structural materials

Cast iron

Description

Cast iron can be used in columns and arches (usually as a column to support a brick arch) and is more commonly found in historic buildings including refurbished buildings. Cast iron is not usually used in beams.

General considerations

Cast iron has a low tensile strength and will lose its strength quickly in fire and this can result in rapid collapse.

It is considered that unprotected cast iron columns should not be exposed to temperatures above 300°C if steel beams are rigidly connected to them and should not be exposed to temperatures above 550°C if timber beams are connected to them.

If a building containing cast iron structures has undergone refurbishment which was notifiable under modern building regulations then there would be a requirement for exposed cast iron structures to be fire protected.

Figure 37: Cast iron columns

Inherent benefits	Inherent hazards
Usually exposed and therefore easy to identify.	Failure is brittle with little or no warning. Sudden cooling from firefighters' water jets can cause cracking due to thermal shock which can result in failure of the structural member.

Fire and rescue service considerations

- Consider potential for sudden collapse
- Consider the excessive weight of falling cast iron elements
- Avoid rapid cooling of affected structure due to thermal shock.
- Consider the use of thermal imaging cameras to monitor temperatures of structure
- Monitor adjacent compartments or structures for conducted heat transfer

References

Bussell, M. Appraisal of existing iron and steel structures. Steel Construction Institute, 1997.

Barnfield, J.R and Porter, A.M. Historic Buildings and Fire: Fire Performance of Cast-Iron Structural Elements. The Structural Engineer, volume 62, 1984.

Manuals of Firemanship

Structural materials
Cellular steel
Description Cellular steel is used as part of the structural frame and typically as beams. There a several types of cellular steel but in general they are formed by welding, together sections of steel or steel plates in certain patterns which results in a lattice or open web type structure. The open structure of cellular steel makes it easy for services to be run through the beams and to achieve long spans.

Figure 38: Cellular steel

General considerations

Cellular steel beams are formed by the welding of cold-rolled steel bars to top and bottom plates or the cutting of a beam along a castellated line and then welding the sections back together. These beams most commonly support floors of composite metal deck.

There are a number of different failure modes of cellular steel due to the construction of this type of steel, namely the aforementioned welding and/or cutting. Predicting which failure mode will take place is possible but requires expert knowledge.

Inherent benefits	**Inherent hazards**
Steel is non-combustible and presents no risk of firespread from direct burning. The behaviour of steel is predictable.	Rigid connections may cause failure during heating and cooling. There is more welding used within the construction of cellular beams and this can cause inherent weakness in fire. Localised failure of web posts ('columns' within the cellular beams) can occur. May be hidden and therefore difficult to identify. Unseen damage to the fire protection of steelwork may have implications on firespread and structural collapse elsewhere in the building.

Fire and rescue service considerations

- Consider potential of collapse
- Consider duration of exposure and temperatures involved in exposure of cellular steel to heat
- Use of structural engineers to assist in assessing structural stability
- Monitor adjacent compartments or structures for conducted heat transfer
- Consider cooling affected structures to prevent collapse
- Firefighters should not attempt to predict the mode of failure during the course of an incident; this

would require an in-depth level of structural engineering knowledge
References

Structural materials
Cold-rolled steel

Description

Steel formed by the method of cold rolling. This method is generally used to produce lightweight steel, generally no more than around 2-3mm thick.

General considerations

The mechanical properties of cold rolled steel are much the same as hot rolled steel and steel in general however the smaller dimensions commonly used within cold rolled steel production will provide reduced yield strengths and inherent fire resisting characteristics that come as a function of size. This is much in the same way that lightweight engineered timber will compare to large traditional timber.

Figure 39: Lightweight steel stud partitioning

Cold rolled steel will generally be found within stud partitions, within external load bearing walls, as secondary beams within floor systems and cold rolled bars within reinforced concrete.

If used to form load bearing members, cold rolled steel is likely to be encased within some form of passive fire protection in order to protect it from the effects of fire.

Inherent benefits	**Inherent hazards**
The behaviour of steel is predictable Steel is non-combustible and presents no risk of firespread from direct burning.	The structural integrity of cold rolled steel within elements of construction is reliant on connections, which are often prone to failure (e.g. rivets or tap-in screws designed to hold at ambient temperature may snap upon expansion of steel members). The lighter nature of cold rolled steel necessarily means that once these are attacked by fire, failure will occur more quickly and potentially suddenly than hot rolled steel.

Fire and rescue service considerations

References

Structural materials
Concrete
Description Concrete is a material that is formed from cement and Aggregates. Types of concrete include pre-cast, high-strength, pre-stressed and hollow core. Almost always reinforced in some way (usually steel).

General considerations

Concrete is a material comprised of an aggregate and a binding material, commonly cement. It possesses high compressive strength but has low tensile strength as a result of its structure.

Figure 40: Reinforced concrete

Concrete undergoes a similar degree of thermal expansion to steel when it is heated. At elevated temperatures, that are consistent with post flashover compartment fires, spalling of the concrete can occur. This effectively reduces the amount of concrete material available to support or transfer a load, which can lead to failure. Concrete possesses a high thermal mass and tends to be used with large cross sectional areas, hence tends to take some time to be significantly heated and affected by fire. Where concrete is used in a building to provide fire resistance to an element of structure this function is almost always provided by the thickness cover of concrete to the internal reinforcing material. When spalling has occurred and the reinforcing material is visible failure of concrete element of structure is considered to be imminent.

Inherent benefits	**Inherent hazards**
Pre-cast: Quality control. Factory construction usually leads to more consistent material. Generally performs well in fire. Large members. Generally predictable collapse preceded by spalling.	Steel reinforcement may become exposed and/or corrode, leading to loss of load-bearing capacity if exposed to high temperature. Difficult to identify types of concrete. High strength concrete may be prone to spalling. Pre-stressed concrete may collapse with no warning. Potentially explosive collapse. Hollow core (usually 1.2m slabs): firespread within voids. Connections within concrete structures are critical however they are prone to failure.

Fire and rescue service considerations
• Consider ventilation as soon as possible due to the thermal capability of concrete • Consider signs of spalling of concrete may be an early indicator for possible collapse
References
Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001 – Chapter 5

Structural materials

Engineered timber

Description

Figure 41: Engineered timber I-beams

Solid timber joists are being replaced by engineered products such as timber I-beams and metal web joists which are being used as floor joists. These are lightweight and rigid and can span much larger distances without the need for intermediate structural support.

Figure 42: Metal web joists

General considerations

Engineered timber is reliant on fire protection measures. It will provide fire resistance for a defined period of time as a complete system under standard fire testing, This differs from traditional timber which has inherent fire resistance relative to the amount of excess or sacrificial timber that is present.

Engineered joists usually have a smaller cross section than traditional timber joists. As these joists have a relatively open structure firefighters need to be aware that this creates a continuous floor void unlike traditional timber floor joists. Also this open structure allows for services to be easily passed through the floor voids.

Holes can be created in timber I-beams to pass building services through which may weaken the beams however; these holes can be pre-drilled and part of the design.

Services are easily passed through steel web beams due to their open structure.

Inherent benefits	Inherent hazards
Can often be identified from building type and age with reasonable probability (e.g. domestic buildings built in last 5 years).	Prone to rapid failure once fire protection is breached. Usually hidden behind passive fire protection and therefore not readily visible for identification. Concealed firespread in floor void.

Fire and rescue service considerations

- Consider effects of fire (duration and intensity)
- Liaise with the Responsible Person, or appointed competent person, for advice on fire engineered strategies

References

Modern methods of house construction: a surveyors guide, BRE Trust, 2005

A guide to modern methods of construction - NF 1. NHBC Foundation, 2010

Structural materials
Glass
Description Glass used for structural purposes for example glass floors, glass bridges. See also External finish: glazing and Windows: glazing

General considerations

Structural glass is glass that has been manufactured so that it may be used in the construction of floors, walls and other load-bearing structures usually to maximise the amount of natural daylight passing through a building.

Glass usually fails quickly when exposed to fire but when undamaged may be difficult for firefighters to break. Structural glass may be manufactured to have some degree of fire resistance.

Figure 43: Structural glass

Inherent benefits	**Inherent hazards**
Glass is non-combustible and therefore will not contribute fuel to a fire. Firefighters may be able to see through glass to different floors of the building. Structural glass will usually be on display and therefore should be easy for firefighters to identify.	Glass does not have to be directly involved in a fire for the fire to spread through it by radiative transfer. Glass can crack or shatter as a result of thermal shock (e.g. sudden cooling from firefighters' hose jets).

Fire and rescue service considerations

- Consider that large glass sections may fall a considerable distance from building
- Identify alternative access routes to avoid areas of glazing affected by heat
- Consider working at height procedures when working internal near to where glazing has failed.

References

Structural materials
Historic timber
Description These are large sections of old timber. This type of timber is mostly used as a structural material in older buildings.

General considerations

Historic timber differs only from traditional timber in its cross sectional area and as such should be considered along with traditional timber.

The firefighter needs to remember that condition of historic timber can worsen over time with damage such as rot, infestation (e.g. termites), splits or cracks occurring, which can weaken the timber.

Figure 44: Historic timber

Timber has the inherent ability to protect itself; the build-up of charcoal on the surface of burning timber limits the availability of oxygen thereby insulating the remaining section.

The burning or charring rate of timber is predictable and usually oversized timbers are used as structural elements which provide an amount of "sacrificial" timber built into the construction which may be consumed by the fire before the structural core is attacked. This provides some fire resistance but this is for an unknown length of time.

Figure 45: Historic timber

Inherent benefits	**Inherent hazards**
Usually exposed and therefore easy to identify and as such easy to identify warning signs. Historic timber tends to have a large cross section and will undergo a steady failure; there will be warning signs before collapse. Deep charring or cracking of the timber are markers to look for when assessing likelihood of failure.	Historic timber as a structural material is generally found in older buildings. Concealed spaces in older buildings can allow unseen firespread. Timber exposed to the elements may have become more susceptible to fire than any covered by plaster Will usually pre-date building regulations and post-war building studies and hence the use of historic timber in construction may be different to current uses. Exposed historic timber may sometimes be decorative and not load-bearing.

Fire and rescue service considerations

- Consider the condition of timbers in historic buildings,
- Consider the use of thermal imaging cameras
- Consider the effects of historic building materials used as insulation between floors (nogging)

References

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Miller, H.W. Building Construction for Firemen. London, Crosby Lockwood & Son, 1949

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Structural materials
Hot-rolled steel
Description Steel formed by the method of hot rolling. This method is generally used to produce large steelwork used in beams, columns, trusses and joists.

General considerations

The mechanical properties of hot rolled steel have some similarity with cold rolled steel and steel in general. However, the larger dimensions commonly used within hot rolled steel production will provide greater inherent fire resisting characteristics that come as a function of size. This is much in the same way that large timber rafters will compare to light-weight engineered timber.

Hot rolled steel is likely to be found within structural beams, columns and joists whilst cold rolled steel is likely to be found within stud partitions, external load bearing wall construction and cold rolled bars used within the reinforcement of concrete.

Hot rolled structural steel is usually fire protected in multi-storey buildings using either fire-resisting boards, sprays or intumescent coatings.

Inherent benefits	**Inherent hazards**
The behaviour of steel is predictable Steel is non-combustible and presents no risk of firespread from direct burning. In multi-storey buildings, hot rolled structural steel is usually fire protected and can be reasonably expected to prevent collapse of the building for sufficient time to enable the fire and rescue service to enter and search the building.	Heat transfer through thermal conduction can add to the effects of firespread throughout the building. Steel will lose strength and stiffness at high temperatures (>550°C) causing deformation and possible collapse therefore it should be assumed that after flashover, steel is weakening. Steel may be hidden and difficult to identify within the building. Unseen damage to the fire protection of steelwork may have implications on firespread and structural collapse elsewhere in the building.

Fire and rescue service considerations

- Consider defensive firefighting techniques due to potential early collapse
- Identify whether steel has been protected from effects of fire by cladding and condition of cladding
- Consider the length of time and to what temperature the steel has been subjected to
- Consider the use of thermal imaging cameras
- Monitor adjacent compartments or structures for conducted heat transfer

References

Structural materials

SIPS

Description

SIPS or Structural Insulated Panels are prefabricated lightweight building units of a sandwich construction comprising two layers of sheet material bonded to a foam insulation core. The sheet material can be oriented strand board (OSB) or cement based boards. The foam insulation can be expanded polystyrene, polyurethane (PUR) or polyisocyanurate (PIR).

General considerations

SIPS rely on the bond between the foam and the two layers of sheet material to form a load-bearing unit and essentially are used in the same way as timber frame panels or steel frame panels. However, these panels should not be confused with sandwich panels.

They are typically found in buildings up to three-storeys high but may also be found in taller buildings.

SIPS are reliant on fire protection. Maintaining the structural bond between the various layers in a SIP is a very important factor in fire resistance. Degradation of the exposed SIP face layers has a major impact on overall wall performance in a standard fire resistance test.

Other SIP components, such as jointing, also impact on the fire resilience of SIP construction. Sacrificial plasterboard lining is generally installed, similar to other lightweight forms of construction, e.g. timber frame to ensure adequate fire resistance of SIPs.

In addition to internal plasterboard lining, SIPS also require external cladding to complete construction and these cladding systems can include brick skin and renders.

Inherent benefits	Inherent hazards
	Some foams such as untreated polystyrene will melt before the panel or protection ignites and as a result the panel may lose its structural integrity. Liberation of fire gases A breach of the fire protection and the facing panels can allow for undetected firespread within the panels. Difficult to identify the presence of SIPS and the type of foam insulation being used.

Fire and rescue service considerations

- Consider potential for sudden collapse
- Consider rapid firespread that can lead to flashover in the early stages of the incident
- Consider defensive firefighting due to Rapid and intense heat and smoke build up
- Consider direction of smoke plume on surrounding area consult with Environment Agency

References

Bregulla, J and Enjily, E. An introduction to building with Structural Insulated Panels (SIPs), IP13/04. BRE Press 2004.

Modern methods of house construction: a surveyors guide, BRE Trust, 2005

Structural materials
Stone
Description Stone used as a structural material can be of two main types; natural or cast stone and can be used for blockwork load bearing walls or non-load bearing walls, beams , lintels, columns or arches .

General considerations

Stone is generally considered to be non-combustible and will not contribute fuel to a fire but can undergo failure when affected by fire.

There are numerous types of stone used as structural material and each has individual properties. In general, stone is affected by thermal shock from firefighting activity after exposure to temperatures greater than 550°C but for most stone types this temperature is closer to 700°C.

Thermal shock, either by direct cooling by water or extinguishing the fire, can result in delamination or spalling of the stone. Stone containing quartz, e.g. sandstone and granite, will be weakened by fire and may crack or become friable (crumble or reduced to powder) at temperatures greater than 573°C.

Limestone will undergo calcination of calcium carbonate at temperatures above 600°C and this will rapidly increase beyond 800°C. Calcination will reduce the strength of the stone.

Cast stone is a special form of simulated stone, defined by UKCSA as any product manufactured with aggregate and cementitious binder intended to resemble and be used in a similar way to natural stone. Cast stone is either homogenous throughout or consists of a facing and backing mix. It is used as an alternative to, and manufactured to resemble, natural stone. Cast stone will behave very similarly to concrete.

Cast stone is predominately used for facings and decoration but can also be used in structural beams or lintels particularly around doors and windows.

Inherent benefits	**Inherent hazards**
Stone is non-combustible and will not contribute to fire size. Generally natural stone is easily identified. A large proportion of historic buildings will have structural natural stone.	A very severe fire can result in structural collapse of stone structures. Natural stone is affected by thermal shock and can delaminate or spall particularly when subjected to firefighting jets. This can lead to large sections of stone falling onto personnel below. May be difficult to differentiate between cast stone and natural stone, hence the behaviour of concrete should also be considered.

Fire and rescue service considerations

- Observe structures for potential spalling which can be an early indication of structural collapse
- Prevent direct application of firefighting jets onto heated areas of structural stone
- Consider the use of thermal imaging cameras to monitor temperatures

References

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Chakrabarti, B, Yates, T and Lewry, A. Effect of fire damage on natural stonework in buildings. BRE, 1996.

Technical manual for cast stone, United Kingdom Cast Stone Association (UKCSA). The National House-Building Council, 2011.

Structural materials

Structural timber composites

Description

Structural timber composites (STC) are used as beams, columns and studs for timber frame and also as proprietary structural components.

Typically STC are long in length and/or in deep sections with high strength and light weight. They are generally formed with smaller pieces or layers of timber held together with adhesive.

General considerations

There are numerous types available including glued laminated timber (glulam), laminated veneer lumber (LVL), parallel strand lumber (PSL), laminated strand lumber (LSL) and engineered timber which is explained separately. With the exception of engineered timber these STCs in a general sense are formed using adhesives to hold together smaller sections of timber with slight variations in their process.

Figure 46: Timber composite beam

Unlike traditional timber or historic timber, STCs are generally designed to the specific fire resistance time required and not much beyond that time.

STCs are assumed to behave as historic timber but to a certain extent their behaviour is unknown. There is limited data available particularly with regard to behaviour of the adhesives used, which vary between products.

There is little ‘real world’ experience of the behaviour of STCs in fires.

Inherent benefits	Inherent hazards
Predictable burning or charring rate within a fire resistance test environment. Usually exposed and therefore can be readily identified from their layered structure.	Usually no sacrificial material after the designed fire-resistance period and this can affect the structural integrity.

Fire and rescue service considerations

- Observe known laminated woods, involved in fire, for unexpected behaviour or signs of collapse
- Consider length of time and temperature ranges laminates have been exposed to heat

References

Lancashire R and Taylor, L. Timber frame construction, 5th edition. TRADA Technology Ltd, 2001.

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Structural materials

Traditional or lightweight timber frame

Description

Traditional or lightweight timber frame is typically 38-40mm timber. This can be used as the structural frame of a building and/or for partition wall studs.

General considerations

Modern timber frame buildings utilise traditional or lightweight and/or engineered timber along with wood based sheathing board such as oriented strand board (OSB) or chipboard which imparts rigidity to the frame.

Timber is combustible and its performance is somewhat reliant on fire protection measures (e.g. plasterboard). Lightweight timber and traditional timbers are usually covered or protected by linings either externally or internally.

Traditional or lightweight timber frames along with the sheathing board interact with air filled cavities and provide a combustible fuel should a fire enter this cavity. This is particularly the case if the cavity has not been adequately compartmented with cavity barriers and the fire is allowed to spread unhindered in the cavity.

In some properties traditional or lightweight timber can also interact with composite cladding systems, which if inadequately installed can allow for concealed firespread.

Inherent benefits	Inherent hazards
Timber burns or chars at steady rate and undergoes a predictable, steady collapse which can be identified if the timber is exposed.	Buildings under construction present high risk of rapid firespread and early collapse Little inherent fire resistance. Can become compromised when fire protection is breached. Concealed firespread. Difficult to identify timber frame and timbers are usually not exposed.

Fire and rescue service considerations

- Consider the presence of timber framed construction at any newly built property or development
- Consider the potential for rapid undetected firespread
- Investigate any potential firespread (cutting away of cladding or coverings may be required)
- Consider the use of thermal imaging cameras
- Consider defensive firefighting tactics for timber framed buildings under construction due to rapid firespread and potential early collapse

References

Structural fire engineering digests

Manual of Firemanship: Building Construction and Structural Fire Protection Book 8: Survey of the Science of Firefighting, 1992

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Lancashire R and Taylor, L. Timber frame construction, 5th edition. TRADA Technology Ltd, 2001.

Suppression
Drenchers

Description

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.

General considerations

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.(picture beneficial)
- 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. This type of drencher may also be found in theatres to protect the safety curtain on the stage.
- 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.

An automatic drencher system may be linked to an automatic sprinkler system connected via its own control valve so that a warning is given if the valve operates.

Inherent benefits	**Inherent risks**
May provide pseudo-compartmentation instead of a compartment wall. Can prevent external firespread to adjacent buildings.	Reliant upon good maintenance. Drencher systems as with sprinkler and water mist 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 – slippery surfaces. Inoperative drencher systems may lead to additional hazards if the building design is reliant upon its operation. Reduced visibility due to smoke down drag.

	Water penetration through the building structure.

Fire and rescue service considerations

- Identify if drenchers are operating and location(s) of activation
- The incident commander should appoint appropriate personnel to manage controls such as the main stop valve (to ensure valve remains open)
- Drencher valve should not be closed unless under direct instruction of incident commander
- Consider impact of large volumes of water (environmental effects and/or damage caused to property)

References

Manual of Firemanship: Fire Protection of Buildings Book 9 (A Survey of the Science of Firefighting), 1977

Suppression
Dry powder
Description Suppression system which use dry chemical powder to extinguish a fire.

General considerations	
When introduced directly to a fire, dry chemical powder can extinguish flames almost immediately. Dry chemical powder is intended for use in extinguishing fires involving bulk chemical agents and liquefied gases. Dry powder extinguishers may cause extensive damage if used in the wrong environment as they can become corrosive and abrasive. In an environment where moisture is present the powder can form into an acidic solution.	
Inherent benefits	**Inherent risks**
The presence of dry chemical powder suppression within a building can indicate to firefighters the nature of hazards present within the building.	Dry powder suppression may be toxic or contain irritants. The abrasive or corrosive nature of the dry powder chemical may cause damage to the fabric and contents of the building. This may present clean up issues in the aftermath of the fire.
Fire and rescue service considerations	
References Manual of Firemanship: Fire Protection of Buildings Book 9 (A Survey of the Science of Firefighting), 1977	

Suppression

Foam

Description

Foam systems are designed to provide a homogenous layer of bubbles of aerated firefighting foam concentrate and water over the surface of flammable liquids (class B fires) and/or combustible materials (class A fires). The layer of bubbles will suppress the release of flammable vapours, exclude air, and cool the fuel and hot surfaces.

General considerations

Foam suppression systems are *generally* used for special fire hazards and liquid fires.

Foam suppression systems come in a variety of forms. These may have the ability to control, suppress or extinguish a fire and it is important to identify which one of these methods is in place within a building.

Foam systems carry environmental implications which need to be considered. The properties of foam used in suppression such as foaming, oxygen demand, aquatic toxicity, biodegradability and oil emulsification may impact surface water and groundwater if released into the environment.

Inherent benefits	Inherent hazards
Control of fire size and spread.	Foam systems are difficult to see through to ensure fire is extinguished. They may trap heat so that when foam is removed the fire re-ignites. Foam systems activated over a large area for example an aircraft hangar may cause visual impairment and communication issues during firefighting activities. Wet floors – slippery surface. Hazardous run off from activated foam systems.

Fire and rescue service considerations

- Contain and control run off
- Supplement integrity of foam cover using fire and rescue service equipment

References

BS EN 13565-2:2009 – Fixed firefighting systems. Foam systems. Design, construction and maintenance.

Rupert, W.H, Verdonik, D.P and Hanauska, C. Environmental Impact of Firefighting Foams. Hughes Associates, Inc., 2005

Suppression
Redox and gaseous
Description Redox: Fire suppression achieved by maintaining compartment at reduced oxygen concentration of 10-12% (15% is required for combustion) Gaseous: Fire suppression using halogens Both: Used for special fire hazards and IT systems, compartment-limited

General considerations

Oxygen-reduction (Redox) fire safety systems proactively prevent fire using technology that produces oxygen-reduced (hypoxic) air by partly filtering out oxygen from the ambient atmospheric air. It is important therefore that a Redox protected compartment remains sealed during firefighting activities in order for the system to work. (Include images of Redox warning signs)

Gaseous systems work either by removing oxygen from a hazard to the point where the oxygen levels will not support a fire, or by interfering with the combustion reaction. Gaseous systems using certain agents such as carbon dioxide within an enclosed space can present the risk of suffocation. Additional life safety systems should be in place which would typically include an alarm system to warn of the gaseous systems activation prior to the release of any agents. A gaseous system may be identified by agent storage containers, agent release valves, agent delivery piping and dispersion nozzles.

Firefighters should be aware of the potential for false activation of such systems during searches.

The positive pressure created by the release of some inert agents may be sufficient to break windows and possibly collapse partition walls.

Gaseous systems which use halon alternatives may produce large quantities of corrosive gas, aerosol and liquid as a result of their reaction with the fire. Typically hydrogen chloride (HCl), hydrogen bromide (HBr) and hydrogen fluoride (HF) may be produced.

Inherent benefits	**Inherent hazards**
Control of fire size (in a Redox environment, fires should not occur).	Firefighters should avoid spending a long time in a Redox environment (unless wearing BA) due to the low oxygen concentration. Fire can grow again if the environment is breached and oxygen is allowed in. Halogens used in gaseous suppression systems can lead to production of corrosive gases, which can affect fire kit.

Fire and rescue service considerations

- Maintain integrity of Redox environments
- Reduce unprotected exposure to Redox environments

References

Suppression
Sprinkler systems
Description Sprinkler systems are designed to apply water to a fire once gas temperatures within the local area have reached a pre-determined temperature, which causes activation of sprinkler heads. Only sprinkler heads which are exposed to the required elevated temperature will actuate. Sprinkler heads are connected to a network of pipes and a water supply system, which may be a service main or sprinkler tank with associated pump set, sprinkler valve sets and main stop valve.

General considerations

Sprinkler systems are designed to react and apply a quantity of water for a pre-determined duration based on the anticipated fire hazard. Sprinkler systems are designed to control fires but do not necessarily extinguish the fire although this is not uncommon. The number of sprinkler heads operating simultaneously is designed to be limited to the area involved in fire.

Figure 47: Sprinkler head

Sprinkler heads may activate away from the seat of fire if sufficiently elevated temperatures are attained local to the sprinkler heads. Activation of sprinkler heads may be initiated by glass bulbs or fusible links. Some sprinkler systems may cause remote activation of sprinkler heads where the asset being protected is not within the compartment.

Figure 48: Concealed sprinkler head (exposed)

Sprinkler systems may have been installed for life safety, property protection, business continuity or environmental protection.

Within buildings where fire engineering has been adopted sprinkler systems may have been installed to compensate for the potential omission of other fire protection measures.

Figure 49: Concealed sprinkler head

Sprinkler systems will be connected to an audible sprinkler alarm and may be interfaced through systems such as a programmable electronic fire alarm to operate other building systems. They can also be interfaced to an off-site alarm receiving centre (ARC) which can discriminate between a sprinkler alarm and other fire devices and can therefore selectively advise the fire and rescue service that a fire has broken out.

In large buildings sprinkler systems may have been installed to comply with recommendations of either the insurer or statutory guidance. Modern life safety sprinkler systems commonly incorporate sufficient resilience and redundancy in the design to ensure their operability, however, older systems, or systems installed for property protection, business continuity or environmental protection reasons, may not been designed for enhanced reliability to ensure operation in all circumstances.

Attending firefighters may need to turn sprinkler systems off. Caution is advised to ensure that an operating sprinkler system is not turned off prematurely and firefighters should satisfy themselves that subsequently doing so will not increase the severity of the fire and conditions for firefighters. Local familiarisation is recommended to confirm location of water supply and sprinkler valve sets. In addition, increasing numbers of sprinkler systems such as those in schools are provided with a fire service inlet connection to augment the sprinkler water supply.

Sprinkler heads may be concealed for decorative reasons.

Inherent benefits	**Inherent hazards**
Working sprinkler systems control the spread and size of a fire. In many cases fires will be extinguished or need no additional firefighting activity.	Wet floors – slippery surfaces. Reliant upon good maintenance. Inoperative sprinkler systems may lead to additional hazards if the building design is reliant upon its operation. Reduced visibility due to smoke down drag. Water penetration through the building structure.

Fire and rescue service considerations

- Identify if sprinklers are operating and location(s) of activation
- Appoint personnel to main stop valve (ensure valve remains open)
- Sprinkler valve should not be closed unless fire is under control. The valve should only be closed under direct instruction of the incident commander.
- Consider isolation of sprinkler alarm when appropriate to improve fire-ground communications
- Consider impact of large volumes of water (environmental effects and/or damage caused to property)

References

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Scottish Technical Standards

Building Regulations (Northern Ireland) – Technical Booklet E (Fire Safety) October 2012

BS EN 12845:2004 – Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance.

BS 9251:2014 – Fire sprinkler systems for domestic and residential occupancies. Code of practice LPC rules and Technical Bulletins

BAFSA Information Files (especially BIF 11 Sprinklers and the Fire & Rescue Service)

Suppression

Steam

Description

The use of steam as a suppression agent is more commonly used in ships but it is occasionally used where flammable liquids are stored.

General considerations

This is a rare and archaic system but may still be encountered in certain building types. The space or compartment where this type of system is being used will need to be airtight for it to be effective.

Fixed piping is generally used to connect the boiler with the nozzle arranged to direct the steam on to the risk. It is usual to provide a main valve, either itself designed to open slowly or else fitted with a bypass which must first be opened. This is to provide warning to any personnel in the area that steam is being used and to leave the area. This also protects the pipes against a pressure surge.

Valves for steam systems are commonly located outside the protected compartment.

It is also possible to have installations with a sprinkler type layout with fusible-link type sprinkler heads. With these types of installations, water is kept in the pipes between the steam and the heads to avoid condensation and to prevent steam actuating the sprinkler head.

Inherent benefits	Inherent hazards
Control valves are commonly located outside the protected compartment.	Activation of system may be harmful to people in the vicinity. Generally operate in an air-tight environment.

Fire and rescue service considerations

- Close system before committing personnel to controlled areas
- Rotate crews regularly

References

Manual of Firemanship: Fire Protection of Buildings Book 9 (A Survey of the Science of Firefighting), 1977

Suppression

Water mist

Description

A water mist system is a fixed fire protection system that uses water to control, suppress or extinguish a fire. The system comprises automatic nozzles attached to a piping system containing water and connected to a water supply. At operation, the water mist system discharges a cone of spray containing small water droplets that fills the protected zone with water mist. Some systems additionally discharge other gases or include additives.

General considerations

Water mist systems as a means of fire safety protection are relatively new within the UK. Recent work has been done in the way of developing British and European standards for components and systems in order to assist with providing assurance of the effectiveness and reliability of these systems.

Due to the relatively new technology for certain more recent applications and the variations in the way different manufacturers products and systems work the fire and rescue service should be aware of the risks inherent if such a system should fail to operate as intended, particularly if a water mist system has been installed as a compensatory feature in meeting the functional objectives of the Building Regulations.

Water mist systems may have been installed for various functional objectives including life safety, property protection, business continuity or environmental protection.

Water mist systems are *generally* employed as a means of property and asset protection and should not be confused with sprinkler systems despite their similarity in appearance. Water mist systems operate by means of removing both heat and oxygen from the fire triangle as opposed to the heat alone which is removed by a sprinkler.

Firefighters should be aware of the large amounts of steam which may be produced by the interaction of the water droplets with the heat from the fire.

Water mist systems come in a variety of forms. These may have the ability to control, suppress or extinguish a fire and it is important to identify which one of these methods is in place within a building.

It may be important to consider the shutting down of air flows within the area of operation of the water mist system such as ventilation systems in order to minimise any water mist lost from the intended protected volume.

Inherent benefits	**Inherent hazards**
Working water mist systems can control, suppress or extinguish a fire.	Wet floors – slippery surfaces. Reliant upon good maintenance and diligent installation. Inoperative water mist systems may lead to additional hazards if the functional objectives of the building are reliant upon its operation. Water penetration through the building structure. Large quantities of steam may be produced.

	May cause reduced visibility due to smoke down drag.

Fire and rescue service considerations

- Appoint personnel to system control valve (ensure valve remains open)
- System valve should not be closed unless fire is under control (The valve should only be closed under direct instruction of incident commander)

References

Technical Guidance Note: Watermist Systems – Compliance with Current Fire Safety Guidance. WaterMist Co-ordination Group, Issue No 1, February 2012.

William, Dr. C and Jackman, Dr. L. An independent guide on water mist systems for residential buildings. BRE, 2006.

Ventilation and ducting	
Natural ventilation	
Description The circulation and renewal of the air inside a building is effected by a combination of air entering from outside the building and air currents generated inside. Air enters on the windward side through doors, windows and ventilators and is drawn out by suction on the leeward side and up chimneys.	

General considerations	
Means of natural ventilation include windows, doors, flaps, grills or louvres which are all in essence holes in the outer walls or roof of a building. Air bricks are one of the most common in use which may be placed at a high level as an outlet in a room with no chimney flue. They may also be placed in order to ventilate beneath a wooden ground floor. Low level air inlets are less common in modern buildings but many old buildings have them. These are often screened by a metal tube in order to deflect air upwards. (see below) Automatic opening ventilators (AOVs) or louvres may be present in more modern buildings and may also be rain sensitive.	
Inherent benefits	**Inherent hazards**
AOVs may be used as a means of smoke control within a building. Natural vents in a building can allow for signs and symptoms of fire development to be visible from outside the building	Air bricks may allow for build of combustible materials within external wall cavities. Natural roof ventilation may tend to draw fire into roof spaces.
Fire and rescue service considerations • Consider the potential of adverse wind effects with regard to natural ventilation • Investigate sources of natural ventilation, inlets, pathways and outlets • Consider appropriate intervention to control air flow	
References Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001	

Ventilation and ducting
Mechanical ventilation
Description The mechanical circulation and renewal of air inside a building by a system of fans and ducting.

General considerations

A mechanical ventilation system will act to either, a) extract stale air from a building with fans and replace with fresh air via doors and windows etc. b) Force fresh air into the building with fans whilst stale air finds its way out through doors and windows etc. c) Force fresh air into the building using fans and also force out stale air from the building using fans.

Mechanical ventilation systems may also include systems such as air-conditioning systems, Dust extraction systems and fume extraction plants and are likely to be constructed from cold-rolled steel.

Any system of mechanical ventilation should be designed to ensure that, in a fire, the ductwork does not assist in transferring fire and smoke through the building and put at risk the protected means of escape from the accommodation areas. This should be by means of preventing a fire from entering or leaving the ductwork, limiting the spread of fire, smoke and other products of combustion within the ductwork and preventing a breach of the integrity of an enclosing fire-resisting element of construction where penetrated by ductwork.

Systems may therefore rely upon the provision of fire dampers at specified locations within the ductwork being correctly installed and maintained. Systems may also rely on the correct provision and maintenance of fire resisting ductwork, fans and filters. The fire and rescue service should therefore be aware of the possibility of smoke and flame spread through mechanical ventilation ductwork or breach of fire into or from ductwork.

Recirculation systems (type C above) should shut down or discharge air to the open air upon activation of smoke or fire alarms. It should be considered however that the system may not have been designed correctly. It must also be a consideration for all three forms of mechanical ventilation system that the system may still be running upon the arrival of the fire and rescue service and that any incorrect design, change of layout or use of the building since the initial installation of the mechanical ventilation system may lead to smoke spread within the ductwork causing means of escape routes (firefighting access routes) to be compromised.

In the case of dust extraction ventilation systems the fire and rescue service should be aware of the possibility of dust explosions when an ignition source is provided within a dusty environment combined with the correct mixture of oxygen.

The ease or difficulty of access to mechanical ventilation ductwork may be an indicator of the likely maintenance levels within the ductwork upon arrival of the fire and rescue service and potential for build-up of combustible materials within the ductwork.

Inherent benefits	**Inherent hazards**
Mechanical ventilation may be used as a means of smoke control by the fire and rescue service.	Mechanical ventilation ductwork may allow for the spread of smoke and flame (potentially undetected) through the ductwork

	Access to ductwork via access hatches may be difficult. Poor maintenance may allow for build-up of combustible materials within the ductwork. Heat from fire and smoke may affect the integrity of unprotected ductwork that is made of cold-rolled steel

Fire and rescue service considerations

- Liaise with the Responsible Person who will ensure only a competent person operates any integrated ventilation system
- Consider the potential for build-up of combustible materials in older installations
- Consider the use of thermal imaging cameras to detect hidden firespread

References

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Health Technical Memorandum 05-02: Firecode – Guidance in support of functional provisions (Fire safety in the design of healthcare premises). Department of Health, 2014.

Fire Service Manual, Volume 3, Fire Safety, Basic Principles of Building Construction, 2001

Ventilation and ducting
Stack effect
Description A phenomenon caused by temperature differences between air inside and outside a building. Buoyant forces felt by the less dense warm air within a building cause it to rise and leave the building at high levels, allowing for cool air outside to enter the building at low levels.

General considerations	
Stack effect is common within the UK as buildings are generally heated to the point where the air within the building is significantly warmer than the cold air outside the building. If a scenario occurs where this situation is reversed, smoke stratification can occur at much lower levels than may have been considered during the design of the building's natural or mechanical ventilation system. This is more likely to occur during the summer months.	
Inherent benefits	**Inherent hazards**
Should provide favourable smoke buoyancy at ambient conditions within the UK	Reverse stack effect may cause a reduction in smoke buoyancy within a building during summer months. Extraction flow rates for which natural or mechanical smoke control may have been designed could be reduced. Stack effect may create adverse conditions for pressurized systems such as pressurisation stairs provided within firefighting shafts.
Fire and rescue service considerations • Consider firespread throughout building • Consider the use of thermal imaging cameras	
References Morgan, H.P, Ghosh, B.K, Garrad, G. Design methodologies for smoke and heat exhaust ventilation, BR368. BRE Press, 1999	

Vertical circulation
Access hatches
Description Access hatches provide access to roofs, lofts or roof voids and can range from a panel through which a ladder can be pitched to a small hinged door with a ladder or steps attached.

General considerations Access hatches can be provided to allow access for maintenance of plant or machinery or they can allow access into roof voids or onto roofs. Access hatches are generally only large enough for one person to pass through at a time and may not be large enough for a firefighter with full breathing apparatus (BA) to pass through.	
Inherent benefits Some hatches have built-in steps or ladders to allow easy access.	**Inherent hazards** Hatches may restrict access to a fire. May be difficult to open the hatch either due to the fire or due to it being at height. Working at height may need to be considered. Debris may fall from above on opening a hatch.
Fire and rescue service considerations • Use appropriate door entry techniques • Dependant on location of hatch consider working at height equipment	
References	

Vertical circulation	
Dumbwaiters	
Description Dumbwaiters are a method of conveyance similar to general lifts, for the transport of items such as food within restaurants or books within Libraries	

General considerations Dumbwaiters connect floors therefore there is a possibility that they may contribute to the spread of smoke and fire between compartment floors if they are located outside of a protected shaft.	
Inherent benefits	**Inherent risks** Dumbwaiters may allow for the spread of smoke and fire between compartments.
Fire and rescue service considerations • Consider firespread breaching compartment • Investigate for undetected firespread • Consider the use of thermal imaging cameras	
References Manual of Firemanship: Fire Protection of Buildings Book 9 (A Survey of the Science of Firefighting), 1977	

Vertical circulation	
Lifts	
Description Lifts are a method of conveyance for passengers or equipment between different levels or points within a building. Lifts referred to in this section do not include firefighting lifts found in firefighting lifts.	

General considerations	
Lifts may be designed using hydraulics or a cable system. Within a cable system the control system and the machine room will generally be located above the elevator shaft. Hydraulic lifts consist of a cylinder and piston connected to a fluid pumping system which will be located beneath the lift shaft. Hydraulic lifts are unlikely to be present within taller buildings (Rule of thumb - Hydraulic lifts accessing ten stories require nine stories of digging to allow for the cylinder and piston (expensive)). Lifts may be located on the outer envelope of the building as well as within the building. General lifts should not be used by the fire and rescue service during firefighting operations. General lifts may not be available to the fire and rescue service during the whole of firefighting operation. Lifts within buildings may be for general use by people and for the transport of goods or equipment. However some lifts may be specifically designed to also accommodate the evacuation of disabled occupants. Because lifts connect floors there is possibility that they may contribute to the spread of smoke and fire between compartment floors	
Inherent benefits General lifts may be provided within protected shafts or have lobbied protection	**Inherent hazards** Lift shafts may allow for the spread of smoke and fire between compartments Incorrect identification of firefighting lift
Fire and rescue service considerations • Investigate lift shaft for presence of smoke	
References Approved Document B	

Vertical circulation
Stairs
Description Stairs are an element of construction designed to carry a load. Stairs referred to in this section do not include firefighting stairs found in firefighting shafts.

General considerations	
Stairs may be constructed from timber, stone, concrete or glass and create an area of circulation from their base to the floor(s) above. Prior to Building Act 1984 there was little control on the design of stairs, therefore consideration should be given to reduced height clearances between the stair and the bulkhead or apron above and varying riser heights, particularly in older buildings. Trip hazards are common on staircases and may include obstacles such as stair gates.	
Inherent benefits	**Inherent hazards** Stairs may have insufficient capacity for the complete evacuation of the building particularly in high rise buildings (greater than 18m). Stairs are not required to be fire resisting and therefore may be prone to sudden collapse when exposed to fire.
Fire and rescue service considerations	
References	

Windows	
Frames	
Description Window frames are commonly constructed from timber, uPVC, steel or aluminium.	

General considerations	
Window frames constructed from timber or steel will usually resist firespread into the wall cavity if they have been fitted correctly. However, aluminium and uPVC frames require separate cavity-closers to prevent firespread into the wall cavity. In older buildings, timber window frames may be designed to be partially load-bearing; replacement window frames may not have been designed with the same load-bearing capacity as the original frames.	
Inherent benefits Trickle venting may aid early smoke identification from outside the building	**Inherent hazards** Incorrectly fitted or damaged frames may allow fire to spread into the wall cavity. Damaged frames may fall out of the window opening.
Fire and rescue service considerations • Consider potential firespread into cavities if window frames have been poorly installed • Consider the use of thermal imaging cameras • Poorly fitted frames may fall out due to fire or heat exposure	
References	

Windows

Glazing

Description

Window glazing can consist of single or multiple (most commonly two) panes of glass. It can also be made from plain, Georgian wired, fire-resisting or security glass.

See also: External finish: glazing and Structural materials: glass

General considerations

The various types of glazing all carry their own specific properties.

Plain glass will fracture and shatter when exposed to sudden temperature rises and so offers little protection against the passage of fire. Increasing the number of layers (i.e. double or triple glazing) may increase the amount of time for which the glass provides a barrier to fire and smoke. However, note that clear glass provides no barrier to radiant heat and its time to failure is known to be extremely unpredictable in fire.

Fire-resisting windows are often used to protect external escape routes or form part of a compartment boundary and therefore are likely to be part of the building's fire safety measures. It is important to identify fire-resisting glazing and its purpose. Fire-resisting glazing may also be designed to become opaque when it is heated so that the transfer of radiant heat is limited or eliminated.

It is difficult to break fire-resisting glazing (which can be 20mm thick), Georgian wired glazing or security glazing. Layers of plastic built into security glazing may burn when exposed to fire.

Inherent benefits	Inherent hazards
Can be used to ventilate fire or gain access for rescue. Window failure can give clues as to rate of fire build-up.	Window panes can fall out, crack or shatter, particularly as a result of thermal shock (e.g. sudden cooling from firefighting jets). This is a particular problem with toughened glass. Glazing does not have to be directly involved in a fire for the fire to spread through it by radiative transfer.

Fire and rescue service considerations

- Consider that glass sections may travel or float a considerable distance from building when falling from height
- Thermal images may be reflected of glass surfaces giving a false indication of the fire location

References

Other
Special fire risk (industrial)
Description Industrial fires can cover a wide variety of materials, processes and can vary enormously in size and complexity. Many fires involve accidental ignition of flammable liquids such as petrol and flammable solvents, which are often used and stored in bulk. However, there are also many fires (usually relatively small) involving solid materials in powder, pellet or granular form. These materials could be foodstuffs such as grain, sugar, and flour, or wood pellets and sawdust, rubber, metals, chemicals and pharmaceuticals.

General considerations

Fires on industrial sites cover a wide range of materials which may be solid, liquids or gases and can be relatively small such as a waste bin or skip fire, or involve huge quantities of extremely flammable liquids such as may be used at top tier COMAH sites, e.g. Buncefield.

The fire and rescue service should be aware of a number of risks associated with industrial fires such as:

- Presence of potentially explosive atmospheres from gases, vapours and dusts (applicable legislation is DSEAR, enforced by the HSE).
- Production of toxic combustion gases and smoke
- Release of radiological contamination
- Release of biological contamination

Various fire protection techniques are employed, such as sprinkler systems in bulk storage and warehouses, water mist in enclosed machinery spaces. such as ship engine rooms, structural steel protection (board, intumescent paint, sprayed coatings) at petrochemical sites, firefighting foam systems at sites with bulk flammable liquids.

Powder processing sites handling flammable dusts and powders may have explosion protection systems which could be in the form of explosion relief panels on dust filters, cyclones or silos; or explosion suppression systems. On some sites process items such as mills may be built to contain the explosion.

Some industries, for example wood and paper processing, often have infra-red spark detection in ducts and pipework linked to a water deluge system.

Sites such as grain import terminals and waste recycling centres can store large quantities of solid materials that can potentially self-heat leading to ignition if the quantity is sufficiently large and they are left for long periods of time. Extinguishing such fires is difficult and time consuming, usually necessitating spreading out time the material to enable cooling from water application. However, constraints of the site may make this difficult to undertake.

Inherent benefits	Inherent hazards
Very large sites such as top tier COMAH sites may have on-site firefighting teams and a 'works' Fire Service, e.g. Wilton petrochem site. Site safety officers or engineers should be able to provide details of materials and quantities involved and inherent hazards associated with their products and processes. Sites with potentially explosive atmospheres should have a DSEAR risk assessment and hazardous area zoning plan indicating the location of flammable atmospheres.	A small fire in a process could be a source of ignition for any existing flammable atmospheres (gas, vapour or dust), resulting in an explosion. For industrial areas handling bulk quantities of powders or dusts, there is a risk of a secondary explosion resulting from a small primary explosion. Care has to be taken by fire and rescue service personnel not to disturb bulk dust deposits to generate a flammable dust cloud that could then be ignited resulting in an explosion. Bulk fires in large stores, tanks or silos can be very difficult to extinguish requiring large quantities of water or foam as appropriate. For bulk solid material stores they may require emptying the storage area of hot or burning material to enable cooling as water penetration can be limited. Depending on the material burning, for example at waste recycling sites, there may be a public health hazard from the smoke and combustion products. Metal fires can burn with extremely hot flames and require special extinguishers.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, and on-site firefighting teams

References

Dangerous Substances and Explosive Atmospheres Regulations 2002 – Approved Code of Practice and guidance L138 (Second edition), 2013

Dust Explosion Prevention and Protection - A Practical Guide, IChemE, 2002

Bowes, P.C. Self-heating: evaluating and controlling the hazards. Building Research Establishment, 1984.

Other
Specialist government guidance
Description Some building types have specialist government design guidance associated with them, outside of the guidance provided in Approved Document B, mostly due to exemptions from Building Regulations.

General considerations

The following specialist government guidance is available:

Prisons

- Custodial Property Fire Safety Design Guide 2008 Revision 2. Ministry of Justice. This guide can be applied to all custodial type properties.
- Police buildings design guide - custody. Policy document, 2009. Home Office.

Hospitals

- Firecode – fire safety in the NHS Health Technical Memorandum 05-02: Guidance in support of functional provisions for healthcare premises. Department of Health.

Schools

- Design for fire safety in schools: Building Bulletin 100. Education Funding Agency. This guide is used for schools and education premises.

Stadiums

- Guide to Safety at Sports Grounds, Fifth edition 2008. Department for Culture, Media and Sport.

Nuclear

- Nuclear power stations have specialist guidance which will be specifically generated by the company running the station

Inherent benefits	**Inherent hazards**
Buildings covered by these pieces of guidance should still meet the overall standard required by the functional objectives of the Building Regulations.	Older buildings may have been constructed under precursors to this guidance, some under Crown exemption, and so may not meet the current standard of the functional objectives of the Building Regulations.

Fire and rescue service considerations

- Liaise with the Responsible Person, or appointed competent person, to identify building features which are available for firefighting

References

Other
Legislation
Description There is a legislative framework surrounding fire safety in buildings.

General considerations

Building Act 1984

This is the primary legislation concerning building work in the UK. Among other things, it makes provision for the preparation of Building Regulations, identifies the duty of local authorities to enforce the Act and Building Regulations, and sets out the basis for design approach, with designers being free to adopt any approach provided they can justify it (e.g. fire engineering). If no alternative approach is put forward, then Approved Documents should be used to inform the design process.

Building Regulations 2010

The Building Regulations set out the duties on the part of those carrying out building work. Specific to fire safety, Part B of Schedule 1 of the Building Regulations requires that buildings should meet certain functional objectives:

- Provision of alarm and suitable means of escape
- Limiting firespread over the internal linings (i.e. in rooms)
- Limiting firespread over the structure (i.e. fire resistance and concealed spaces)
- Limiting firespread over the external envelope of the building (both across the surface of one building and building-to-building firespread)
- Facilities to assist firefighters in the protection of life

The Regulations require that building work should be carried out with appropriate materials and to a suitable standard of workmanship. The Regulations now also require that information concerning the fire safety design of the building should be made available to the Responsible Person to assist in their duties under the Regulatory Reform (Fire Safety) Order 2005.

The Regulatory Reform (Fire Safety) Order 2005

The Fire Safety Order sets out the duties on the part of the Responsible Person (normally the owner or manager of a building) in relation to ensuring the on-going fire safety of the building. The Fire Safety Order takes a risk based approach to fire safety, but does place some specific duties on the Responsible Person. It requires that the Responsible Person carry out a fire risk assessment and that measures should be taken to ensure that the building is suitably safe for all relevant persons. It also makes reference to some general fire precautions to be taken:

- reducing the risk of fire and the risk of firespread
- means of escape
- means of escape being safely and effectively used at all times
- means for fighting fires

- means for detecting fire and giving warning
- arrangements for action to be taken in the event of fire

The Fire Safety Order does not require that anything be introduced to a building for the purpose of firefighting but it does require that existing features for the assistance of firefighters should be maintained to assist them in the protection of relevant persons.

The Responsible Person is required, where necessary, to make suitable arrangements with the fire and rescue service to ensure the safety of all relevant persons.

Responsibility for complying with the Fire (Scotland) Act 2005 and the associated Fire Safety (Scotland) Regulations 2006 rests with the Duty Holder.

Fire and Rescue Services Act 2004

The Fire and Rescue Services Act 2004, among other things, sets out the duties of fire and rescue services to make arrangements for

- Promoting fire safety and providing fire safety advice where requested
- Familiarisation for the purpose of informing firefighting operations
- Water supplies

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