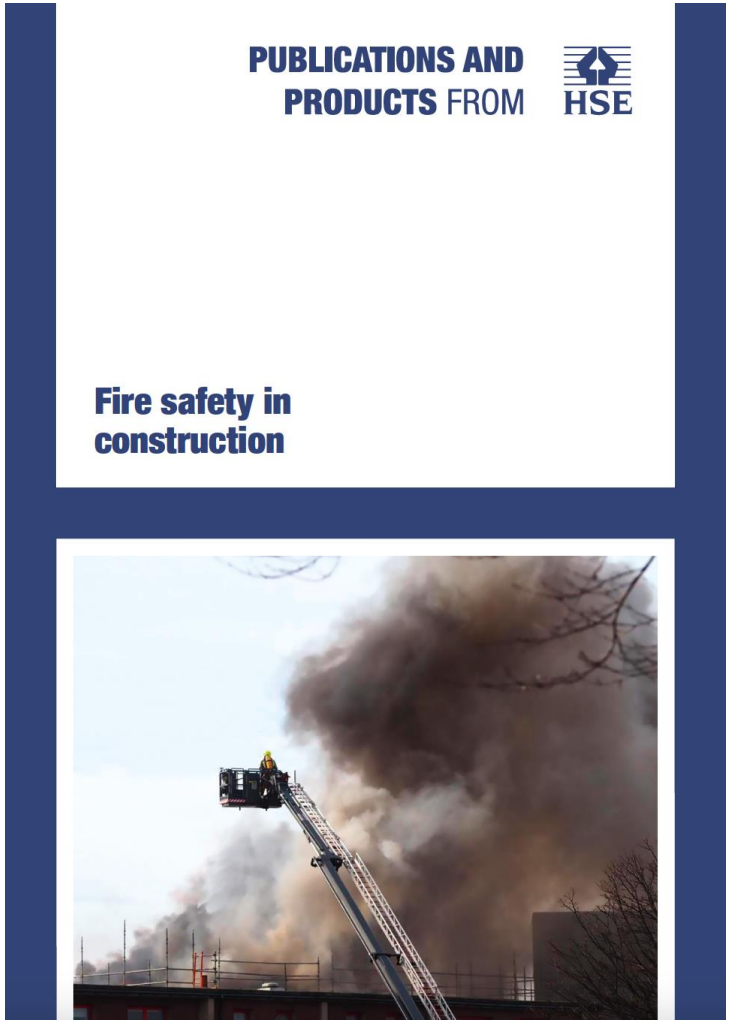
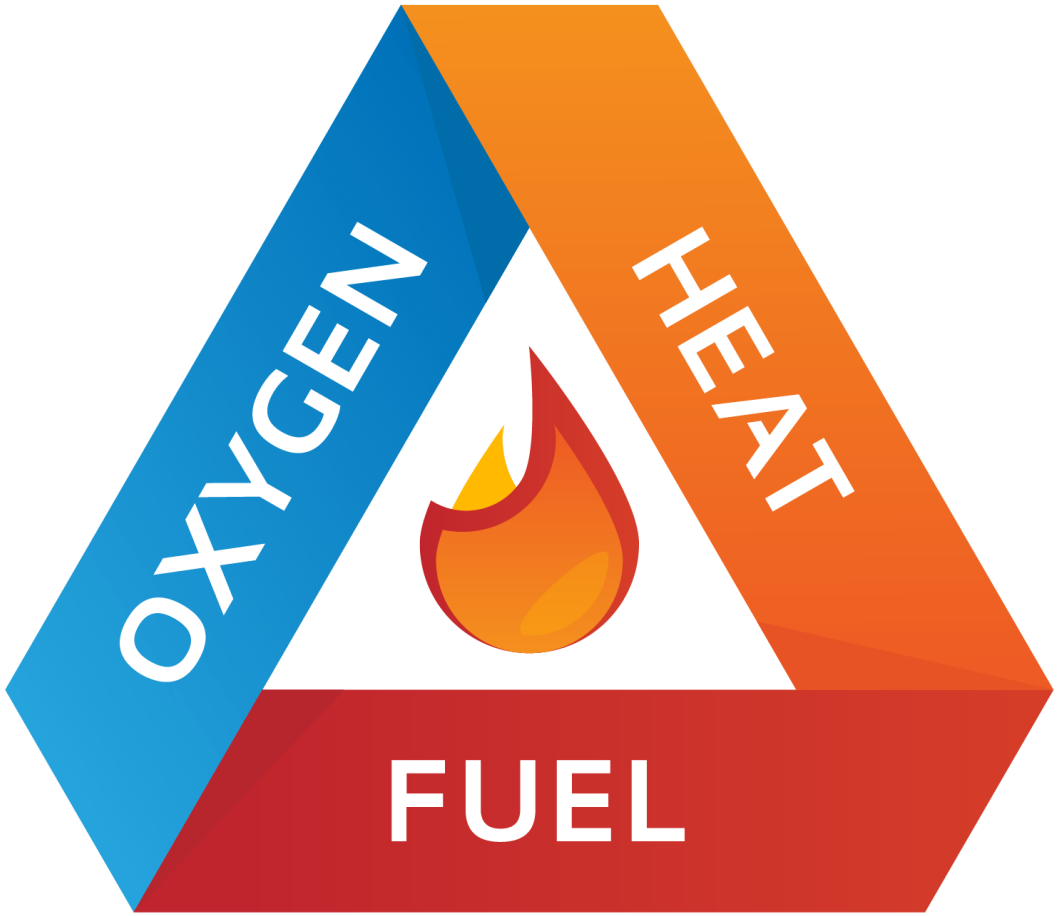
PADDECO

Introduction To Fire Safety



What is fire?

The Fire Triangle:
The triangle illustrates the three elements a fire needs to ignite:
heat, fuel, and an oxidizing agent (usually oxygen).



For a fire to start, these three things are needed

If any one of these is missing a fire cannot start. Taking measures to prevent the three coming together will therefore reduce the chances of a fire occurring.

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Sources of ignition (heat)

Identify the potential ignition sources before and during the construction process by looking for possible sources of heat that could get hot enough to ignite material found on the site.

- hot processes/hot work, such as welding or grinding;
- smokers' material, such as cigarettes, matches and lighters;
- naked flames, such as gas- or liquid-fuelled open-flame equipment;
- faulty or misused electrical equipment;
- light fittings and lighting equipment, such as temporary lighting or halogen lamps;
- bonfires;
- use of oxy-fuel equipment;
- plant and equipment, such as fuel and vehicle exhausts;
- heaters, such as fixed or portable, electrical, gas- or oil-fired heaters in temporary accommodation units (TAUs);
- friction-generated heat from mechanical equipment such as disc cutters;
- static charge from mechanical equipment;
- heat sources, such as gas or electric cooking equipment;
- unsuitable or damaged electrical installations, such as overloads or heating from bunched and/or damaged cables;
- spontaneous ignition and self-heating, such as oil-soaked rags or paint scrapings;
- those deliberately introduced (arson);
- lightning and refracted sunlight.

Sources of fuel

Anything that burns is fuel for a fire. Many materials that can burn are used during construction work. Reducing the quantity of material on site, and therefore the level of fire loading, reduces the chances of fire occurring and limits the extent of any fire.

- components of the structure itself or materials being stored to be used to form part of the structure, such as some composite panels, insulation, PVC and timber;
- rubbish;
- flammable liquids, such as paints and varnishes;
- protective coverings;
- scaffold sheeting;
- volatile flammable materials, such as paints, and thinners;
- fuel for plant and portable equipment; modern batteries or sources of hydrogen (fuel);
- gas cylinders containing flammable gases, such as those used in bitumen boilers and heaters;
- acetylene;
- packaging materials;
- petrol disc cutters and other portable equipment; and
- fall-arrest bags.

Sources of oxygen

Warning symbol for oxidising agents

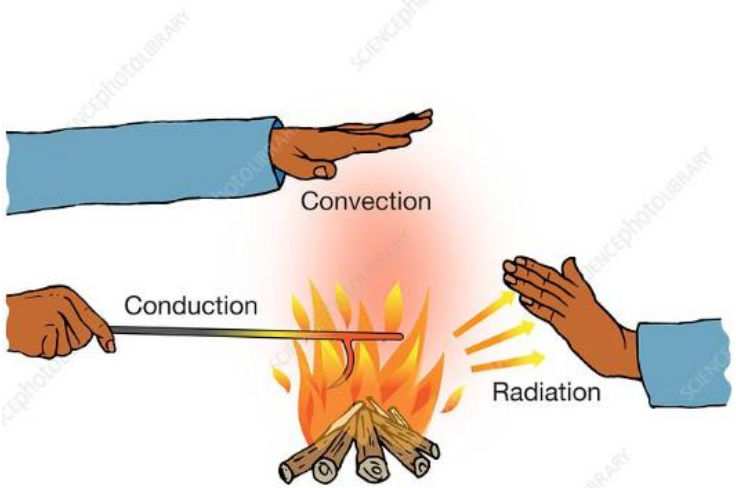
The main source of oxygen for a fire is **in the air around us**. On construction sites this will be natural airflow through doors, windows and other openings.
Wind or the ‘chimney effect’ can also cause increased oxygen to feed the fire. Sources of air flow may be hidden if a building layout has been altered from its original design, resulting in concealed voids.

Additional sources of oxygen can sometimes be found in site processes or materials used or stored on site, such as oxidising agents. They can provide a fire with additional oxygen and so help it burn. These chemicals should have identification on their container (and on their safety data sheet), together with advice on their safe use and storage. Examples include:

- oxygen used in welding processes; and
- oxidising agents (which carry the symbol shown above)

How does a fire spread?

Fire is spread by three methods: convection, conduction and radiation



RADIATION

This heats any solid it strikes in the same way as an electric bar heater heats a room. Any material close to a fire will absorb the heat until the item starts to smoulder and then burn. The radiated heat from large construction site fires can ignite buildings many metres away.

CONDUCTION

Some materials, such as structural steel, pipe work and ducting, can absorb heat and transfer it to the next room, where it can set fire to combustible items that are in contact with the heated material.

CONVECTION

Fire spread by convection is the most dangerous and causes the largest number of injuries and deaths. When fires start in enclosed spaces, such as buildings, the smoke rising from the fire gets trapped by the ceiling and then spreads in all directions to form an ever-deepening layer over the entire room. The smoke will pass through any holes or gaps in the walls, ceiling and floor into other parts of the building. The heat gets trapped in the building and the temperature rises.

Smoke

Smoke produced by a fire also contains toxic gases.

A fire in a building with modern fittings and materials generates smoke that is thick and black, obscures vision, causes great difficulty in breathing and can block the escape routes.

It is essential that the means of escape and other fire precautions are adequate to ensure that everyone can reach a place of total safety before the fire and its effects can trap them in the building or on the site itself.

Toxic smoke inhalation causes more fire-related deaths than do the fires themselves.

General Fire Precautions (GFP)

GFPs include:

- escape routes and fire exits, including signage and lighting;
- measures to limit the spread of fire (compartmentation or venting systems);
- means of raising the alarm;
- fire detection;
- making and communicating emergency plans; and
- firefighting equipment.

The GFPs needed will vary from site to site. Sometimes they will be very simple and other times much more detailed, depending on the risks involved. The GFP requirements will also vary depending on the stage of the project. The risk assessment should consider the impact of construction work on existing GFPs and how requirements will change as the project progresses.

All GFPs need to take account of the nature and size of the site, the number of people present, and the work being done. The number of people present during construction work may differ from the number expected to occupy the building on completion; therefore, additional temporary GFPs may be needed even where the permanent GFPs are commissioned and fully operational.

Fire Protection Systems

Passive Fire Protection

Constructional

- Escape Routes
- Compartmentation
- Behaviour of Construction Materials in Case of Fire

Active Fire Protection

Technical

- Sprinkler Systems
- Extinguishers
- Flues
- Hypoxic Air Supression

Organizational

- Ordinances of Workplaces
- Instructions to Occupants
- Fire Safety Regulations
- Fire Safety Drills and Audits

Public

- Fire Department
- Water Supply
- Emergency Calls
- Fire Alarms

Active Fire Protection (AFP)

A group of systems that require some amount of action or motion in order to work efficiently in the event of a fire. Actions may be manually operated, like a fire extinguisher or automatic, like a sprinkler, but either way they require some amount of action.

Detection - primarily takes place using sensors that detect heat, smoke, or flame and send a signal to alarms throughout the building.

Suppression - anything that can put out a fire through direct action either manually, such as fire extinguishers, or automatically
with indirect or direct release systems.

Ventilation - keeping evacuation routes smoke free with fire-resistant fans.

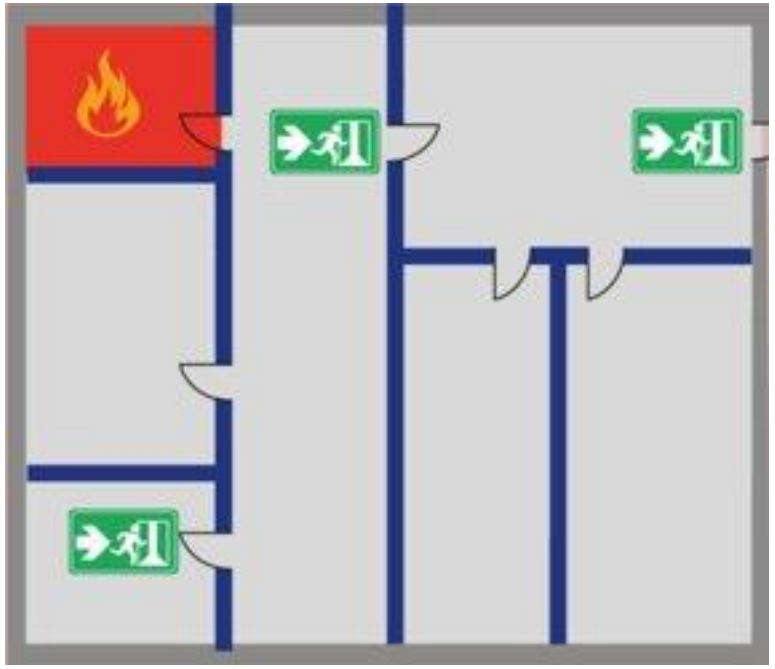
Passive Fire Protection (PFP)

A group of systems that compartmentalise a building with fire-resistance-rated walls/floors, doors and gap-filling measures. Compartmentalising your building into smaller sections helps to slow or prevent the spread of fire and/or smoke from one room to the next.

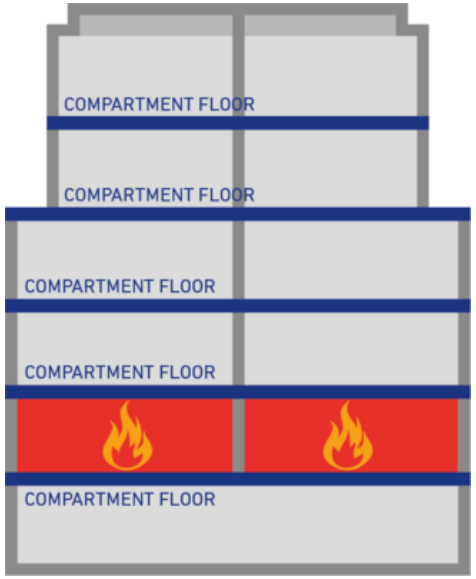
Passive fire protection (“PFP”) is an integral component of a fire safety strategy. It forms an essential element of the structural fire protection and fire safety in a building through, containing fires (known as “compartmentation, slowing the spread of fire with fire-resistant walls, floors and doors (protecting escape routes)

Compartmentation

The fundamental basis of fire protection**. It divides a building into fire compartments to limit the spread of fire**, it can contain single or multiple rooms. The main objective is to contain a fire within the fire compartment separated by fire-resisting walls and floors for a selected period of time.



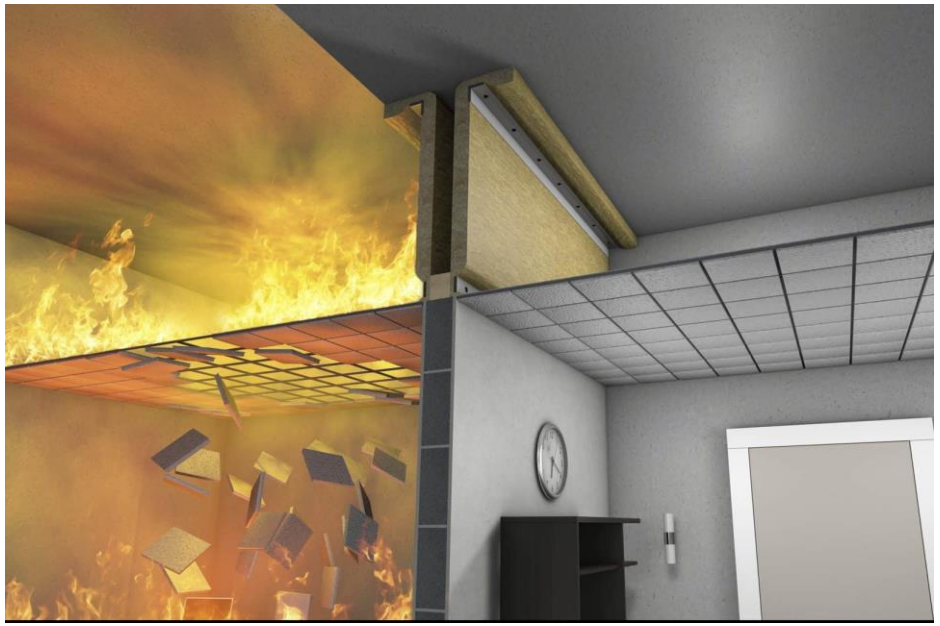
Compartmentation might form a major part of the fire strategy for the completed building, especially for the larger and more complex structures. The early installation and completion of compartments can also provide protection during the construction phase (in accordance with the Building Regulations



Compartmentation

The following are examples where compartments may be breached:

- refurbishment – consider concealed spaces such as behind panelling and cavity walls;
- raised floors for computer suites;
- holes requiring patching;
- voids/openings for services to pass through; and
- damage from site vehicles.



To be effective, the compartment must be complete both horizontally and vertically, without any voids and/or holes passing through it

Fire Emergency Plan

The fire emergency plan must be based on the outcome of the fire risk assessment. The purpose of a fire emergency plan is to set out the action to take in case of a fire and to ensure that the physical control measures identified in the risk assessment will work effectively if needed.

The fire emergency plan must be available for workers, contractors, subcontractors, safety representatives, other occupiers and the enforcing authority. It should be produced before the work begins and any control measures identified must be in place from the start of the construction work.

Some emergencies may require only partial evacuation (for example, where there is a series of separate structures on the site).

It must include:

- the significant findings from the fire risk assessment;
- the measures that have been put in place to
- reduce the risk;
- what people should do if there is a fire;
- the identity of people who have been have nominated with responsibilities for fire safety; and
- the emergency arrangements, to prevent injury, in case of a fire.

Risk assessment checklist

Step 1 Identify hazards

- ✓ Have all potential ignition sources been identified?
- ✓ Have all potential fuel sources been identified?
- ✓ Have all potential sources of oxygen been identified?

Step 2 Identify who might be harmed

- ✓ Have all people at risk been identified?
- ✓ Have the ways in which they might be harmed been identified?

Risk assessment checklist

Step 3 Evaluate, remove, reduce and protect from risk

- ✓ Have sources of ignition been removed or reduced?
- ✓ Have sources of fuel been removed or reduced?
- ✓ Have additional sources of oxygen been removed
- ✓ or reduced?
- ✓ Have the risks to people if a fire occurs been removed or reduced by:
  - determining how fire and smoke will be prevented from spreading?
  - determining whether the escape routes are adequate?
  - determining whether the lighting and emergency lighting are adequate?
  - checking that there are adequate signs and notices?
  - providing a system for fire warning and detection?
  - providing firefighting equipment?
  - regularly testing and maintaining safety
  - equipment?
  - considering whether any other equipment or facilities are needed?
- ✓ Has the impact of the construction work on the GFPs been considered?

Risk assessment checklist

Step 4 Record, plan, inform, instruct and train

- ✓ Have the significant findings of the assessment been recorded?
- ✓ Have the findings of the assessment been used to develop the construction programme?
- ✓ Have the steps taken to remove or reduce the risk been recorded?
- ✓ Have the findings been communicated to everyone on site?
- ✓ Are the findings and assessments available for all to see?
- ✓ Has an emergency plan been produced?
- ✓ Are workers aware of their fire safety responsibilities if there is a fire?
- ✓ Have workers received fire safety training?
- ✓ Is a record of training sessions being maintained?
- ✓ Are joint training sessions and fire drills carried out in multi-occupied buildings?
- ✓ Has a fire drill been carried out recently?
- ✓ Do workers know how their work may pose a fire risk to others on site?
- ✓ Has there been a liaison with other responsible people who occupy the site/premises or nearby properties that may be affected in case of fire?
- ✓ If dangerous or explosive substances are used or stored, have workers received appropriate training?

Risk assessment checklist

Step 5 Review

- ✓ Is there a process in place to ensure the assessment and emergency plan are reviewed before any significant change is introduced?
- ✓ Would a review of the assessment and arrangements by someone independent to the process be beneficial?

Means of escape

Escape routes need to be available and accessible for everyone on the site. Escape routes need to be clear, uncomplicated passageways which are well lit, properly maintained, prominently and kept free of obstruction.

During the course of construction, escape routes are likely to change and possibly become unavailable. It is important to plan and provide replacement routes and to communicate the changes to workers. Proper provision is needed for all workers and visitors wherever they are and however transient the activity, such as workers on the roof in a plant or lift gear room.

Check the exit capacity of the escape route to confirm it is sufficient for the number of people expected to use it. This must take into account any adjacent occupiers who share the escape route

- For new buildings, install these at the earliest stage possible to make them available for those undertaking the construction work.
- For buildings being refurbished, try to arrange the work to make use of existing escape routes and keep them available.
- For demolition sites, ensure protected escape routes and fire doors are kept as long as possible.

Means of escape

In an emergency, escape via a scaffold is difficult. Try to minimise reliance on it. Where practicable, provide well-separated, alternative access from a scaffold to escape routes in the main building floor

- Make sure no flammable or combustible materials are temporarily or permanently stored in any means of escape.
- There should normally be at least two escape routes offering escape in different directions.
- Escape routes need to be appropriate for people who are vulnerable or in a difficult area, such as tower crane operators or people with a health condition or impairment, and suitable support provided.

	Fire hazard		
	Lower	Normal	Higher
Alternative	60 m	45 m	25 m
Dead end	18 m	18 m	12 m

Guidance on the maximum travel distances from a work area to a place of safety.

Fire doors

Fire doors are specialist doors which have been tested against the elements and purpose-built to withstand roaring fires for as long as possible. They enable buildings to compartmentalise and delay the spread of fire from one area to another and form a crucial part of a passive fire protection strategy.

- ✓ The minimum period of fire resistance considered appropriate for protected stairways is 30 minutes, and the fire doors and door set must be designed and installed to meet this standard.
- ✓ The fire doors leading to the protected stairway and the final exit from it must open outwards in the direction that people will escape (if more than 60 people are expected to use them).
- ✓ Keep fire doors closed and do not wedge them open.
- ✓ The fire doors must be easily and immediately openable from the escape side with a single action and without using a key.
- ✓ If it is necessary to protect a stairway, corridor or other circulation spaces to ensure safe travel distances, the integrity of the enclosure is critical to its safe use in an emergency.
- ✓ It is also important to check that there are no other openings present or made, such as for pipes, wiring and ductwork. If there are, infill them with an appropriate material at the earliest opportunity.

Assembly Points

All designated escape exits from the structure should give direct access to an unenclosed space in the open air at ground level.

From here there must be an unobstructed passageway from the structure to a place of safety where people can assemble and be accounted for. The need for assembly points should be considered at the design stage.

Where the construction site is surrounded by a hoarding or fence and the assembly point is outside this, you will need an adequate number of gates giving access to the assembly point.

Consider the size and location of these assembly points:

- on small sites – the pavement outside may be adequate (provided this does not obstruct the fire and rescue service on their arrival);
- on larger sites – you may need to make arrangements to use an area such as a car park;
- on sites such as chemical refineries – you may have to use a safe refuge such as a plant control room. Where the site is in operation, consult a responsible person from the company regarding a safe assembly point.

Emergency signs

Escape routes need to be clearly indicated by proper signs. The Health and Safety (Safety Signs and Signals) Regulations 1996 set the standards for these signs. They should comprise a white pictogram on a green background supplemented with text if appropriate. See HSE guidance L64 Safety signs and signals: Guidance on regulations16 for further details.

Emergency lighting

Emergency escape lighting illuminates escape routes, firefighting equipment and escape signage to aid escape in case of emergency

Escape lighting does not have to meet normal work standards but must be adequate for people to use the route safely.

In the event of failure of the primary lighting, the emergency escape lighting needs to come on immediately. It may be powered by a battery or emergency generator supply. The lighting should conform to BS 5266–1:2016.

Fire alarms

The aim of any fire warning system is to ensure that people on the site are alerted to make their escape before a fire becomes life-threatening. The essential requirements of the fire warning signal are that it is distinctive, clearly audible above any other noise, or visible, can be heard and is recognised by all the people on the site.

False alarms and unwanted fire signals can be costly on any project and can also lead to complacency in people needing to respond.

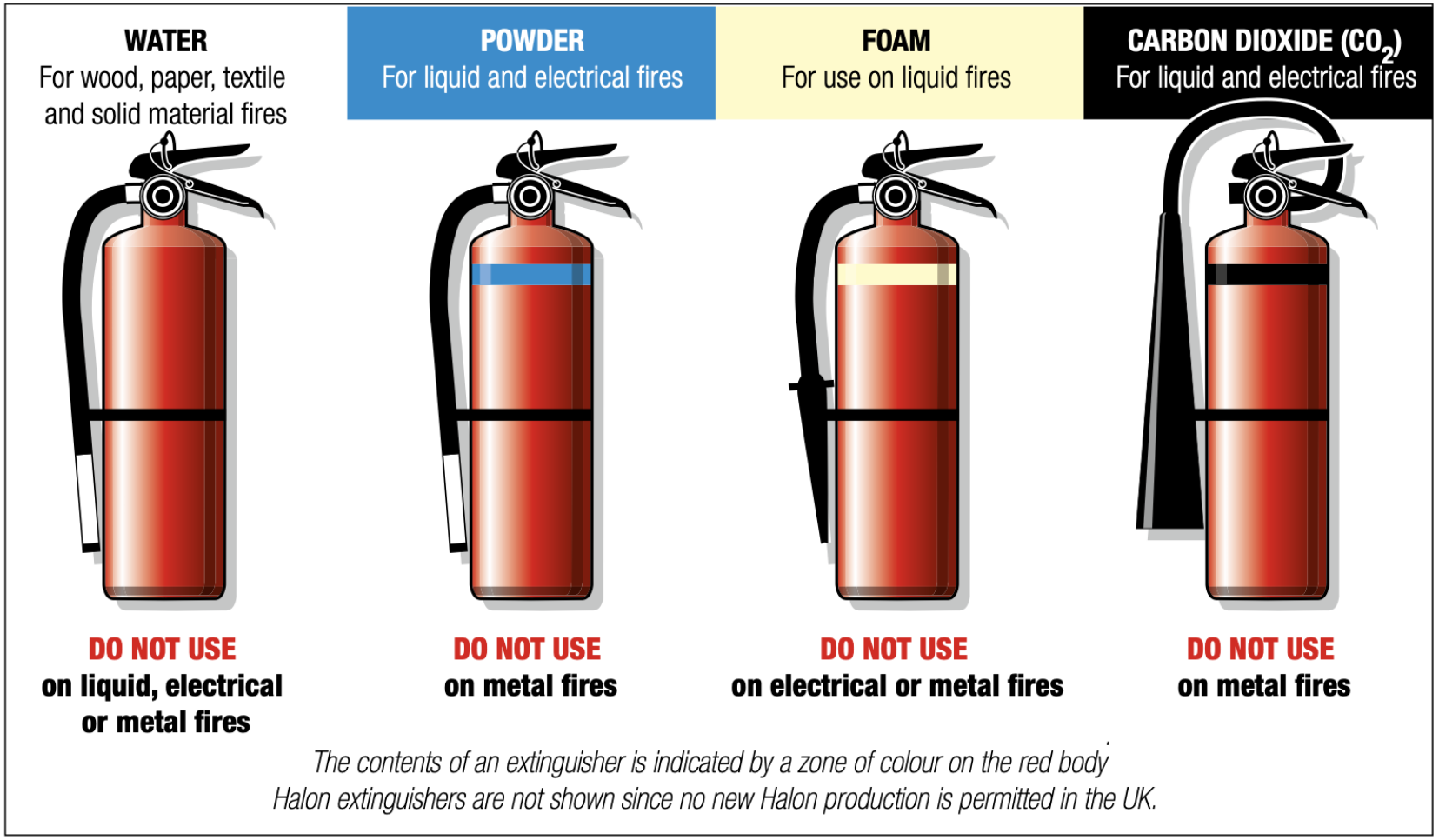
When a fire is detected, and the alarm raised, everyone must make their escape without delay.

The operation, maintenance and effectiveness of the fire alarm system must be regularly checked.

Consider the use of automatic fire detectors during construction work. These are only effective in more enclosed areas and options include smoke or heat detectors. It is not acceptable to cover or deactivate smoke detectors where work generates dust. Instead, dust should be minimised or extracted. Detectors may be appropriate on high-risk sites

Domestic-type smoke detectors are not considered appropriate on complex high-rise sites.

Firefighting equipment



The extinguishers must be appropriate to the nature of the potential fire

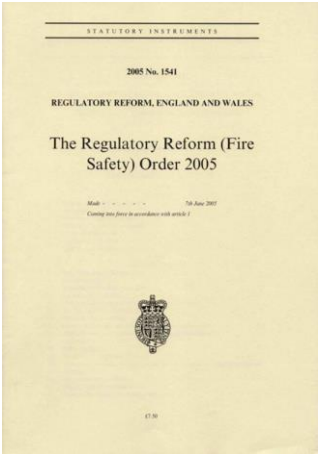
The number and type of extinguishers present depends on the fire hazard that the fire risk assessment has identified. For a typical spread of fire hazards, the following are considered to provide a reasonable level of cover per 200 m2 of floor area, with no fewer than both of the following on each floor:

- one 13A rated water or foam extinguisher;
- one CO2 extinguisher (at least 1.1 kg).

Legal and enforcement responsibilities

The overarching health and safety requirements during construction work, which include fire safety, are provided by the Construction (Design and Management) Regulations 2015.

Fire Safety Act 2021


STATUTORY INSTRUMENTS

2005 No. 1541

REGULATORY REFORM, ENGLAND AND WALES

The Regulatory Reform (Fire Safety) Order 2005

Other legislation covering fire safety includes:

- The Regulatory Reform (Fire Safety) Order 2005;
- The Fire (Scotland) Act 2005;
- The Fire Safety (Scotland) Regulations 2006;
- The Dangerous Substances and Explosive Atmospheres Regulations 2002;
- Fire Safety Act 2021. This Act applies in England and Wales. It makes changes to the FSO, such as the definition of an external wall. Items fixed to said walls, such as scaffolding, form part of the premises;
- Fire Safety (Employee's Capabilities) (England) Regulations 2010;
- The Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013 – the reporting of dangerous occurrences that relate to site fires and/ or explosions.
- The Fire Safety (England) Regulations 2022 (coming into force 23 January 2023). CDM dutyholders must co-ordinate and co-operate on fire safety precautions with the responsible person(s) when construction work is taking place on an occupied high-rise residential building.

Legal and enforcement responsibilities

The general fire safety requirements are made under the FSO and the FSA; in the FSO they are termed ‘general fire precautions’ (GFPs) and in the FSA ‘fire safety measures’ (FSMs).

Construction sites are also covered by the Fire and Rescue Services Act 2004 (in England and Wales) and the Fire (Scotland) Act 2005 in providing the Fire and Rescue Authorities responsibilities to respond to fire and other emergencies to protect life, the environment (including animals) and property.

Who does what? – Client

Responsibilities:

Must make arrangements for managing the project.
Ensure that relevant pre-construction information (PCI) is prepared and provided to other dutyholders.

Actions:

Where the project involves more than one contractor, appoint principal designer and principal contractor with skills, knowledge, experience and organisational capabilities to fulfil the role.
Set out how they expect the project to be managed.
Ensure a construction phase plan is in place and includes project-specific fire risks and the procedures in case of fire.
Allow sufficient time and resources for the project to be planned and completed.
Provide relevant pre-construction information including existing general fire precautions (GFPs), building layout and any presence of hazardous materials such as flammable or combustible materials.
Take reasonable steps to make sure the principal designer and principal contractor comply with their duties.

Who does what? – Principal Designer

Responsibilities:

Must plan, manage, monitor and co-ordinate health and safety in the pre-construction phase of a project.

Actions:

Assist the client in providing the pre-construction information.
Ensure other dutyholders are provided with information relating to fire risk and control and other relevant dutyholders.
Ensure risk of fire is identified, eliminated and controlled, including challenging the decisions made by the designers to ensure they have carried out their duties.
Liaise with the principal contractor to help in the planning, managing, monitoring and co-ordinating of fire risk in the construction phase.

Who does what? – Designer

Responsibilities:

Designers must ensure that the foreseeable risk of fire arising during construction is identified, eliminated and controlled when preparing or modifying designs.

Actions:

Consider the risk of fire when designing the construction project, including choice of building materials and process of build. Consider off-site fire risk including impact on neighbouring properties and their emergency escape routes.
Eliminate the risk or specify risk mitigation measures for the construction phase.
Provide relevant information on risk mitigation measures and residual risks to the principal designer.

Who does what? – Principal Contractor

Responsibilities:

Must plan, manage, monitor and co-ordinate health and safety in the construction phase of a project.

Actions:

Liaise with the client and principal designer in relation to identified fire risks.
As the responsible person, ensure that a site-specific fire risk assessment forms part of the construction phase plan, together with a review process.
Ensure programming considers fire mitigation measures. Ensure fire mitigation measures are implemented.
Co-ordinate contractors and organise their co-operation to ensure fire mitigation measures are in place and maintained.
Inform and consult with people working on site and their safety representatives.

Who does what? – Contractor

Responsibilities:

Must plan, manage and monitor construction work under their control.

Actions:

Co-ordinate and co-operate with the principal contractor and others working on site to ensure fire mitigation measures are maintained and additional risks are not created. Assess and manage fire process safety risks under their control, such as the use of solvents or fire spread.
When there is only one contractor, ensure that a site-specific fire risk assessment is carried out and is reviewed.

Who does what? – Worker

Responsibilities:

NONE

Actions:

Take care of their own health and safety, and others who may be affected by their actions.
Co-operate with duty holders.
Comply with site rules and requirements including fire and emergency procedures.
Report anything they see that is likely to endanger their own or others' health and safety, such as incomplete compartmentation or other inadequate GFPs.

Question Paper