Fire Safety

This may sound like a contradiction, but the problem with fire prevention on a construction site is the absence of a problem. Fires do not occur with frequency or regularity and therefore workers are not particularly concerned about them. Another word for this is complacency, an environment in which danger grows and thrives. It is extremely difficult to motivate someone to take an active interest in fire prevention when the person has never been involved in a serious fire and when they face other, imminent hazards on a daily basis. This leads to the common misconception that fire prevention is someone else's problem.

Almost every construction worker has at one time or another seen someone injured by a fall or being struck by an object. Very few have seen a person burned in a fire, or seen valuable property and months of work reduced to smoke and ashes.

You are responsible for fire prevention at work for your safety and that of your co-workers. The best way to prevent fire is to be on the lookout for possible fire hazards. Be aware of potential fire hazards in the workplace. Know the location of fire extinguishers and other emergency equipment that is available. During an actual emergency, protect yourself. If it is not safe for you to get involved, don't.

Fire safety refers to precautions that are taken to prevent or reduce the likelihood of a fire that may result in death, injury, or property damage, alert those in a structure to the presence of an uncontrolled fire in the event one occurs, better enable those threatened by a fire to survive in and evacuate from affected areas, or to reduce the damage caused by a fire. Fire safety measures include those that are planned during the construction of a building or implemented in structures that are already standing, and those that are taught to workers or occupants of the building.

Fire safety starts with the very step – knowledge , knowledge of what is fire , how it starts, how can we avoid fire related incidents, how many types of fire are there in general, and in case one confronts or face fire then – WHAT TO DO ?

The simple answer to this is knowledge of Fire Hierarchy

Fire prevention planning is the FIRST step to fire protection

The hierarchy of FIRE Safety

Fire Prevention
↓
Fire precaution
↓
Fire protection
↓
Fire Fighting

Fire Prevention ;

Prevention: *The action of stopping something from happening or arising.*

Fire prevention on the other hand is where a fire is prevented from ever happening in the first place. In real terms this is difficult to achieve as fires can happen anywhere at any time. However, there are steps that can be taken to reduce the likelihood of fires starting, this fall under Fire Precaution. Good housekeeping, keeping flammable materials away from the fire sources, basic fire safety training are some of the examples of fire prevention.

Fire Precaution

Precaution: *A measure taken in advance to prevent something dangerous, unpleasant, or inconvenient from happening.*

There are many precautions that can be taken to reduce the risk of fire and reduce the harm and damage a fire will cause.

The first thing to do is carry out a comprehensive fire risk assessment. By identifying areas for improvement and which steps can be taken to make building safer. It will be greatly improve chances of staying fire-free. Installing a good fire alarm system is another precaution which can be taken. To ensure that that it is in good working condition, maintain and test it regularly.

Training of staff and anyone who uses premises is a further good precaution against fire. For example, training employees on the risks of smoking on the premises (which is illegal anyway) or leaving electrical appliances on when they're not being used. Awareness and knowledge is key to preventing fires caused by human error. By following the guidance of local fire authority, adhering to fire regulations and generally using common sense at all times, fire can be prevented and lives can be saved.

Fire Protection

Protection:

1. *The action of protecting someone or something, or the state of being protected or*
2. *A person or thing that prevents someone or something from suffering harm or injury.*

Using this definition we could reasonably assume that fire protection is using a number of actions or devices to protect a person or

building from fire. This could be anything that limits the spread of fire to something that extinguishes fire. Fire alarm system will initially protect you from danger by giving early warning of fire. This will allow you to evacuate the building and stay safe. After fire detection, you might have a fire suppression system in place to extinguish the fire. A fire suppression system could constitute a sprinkler system or fire extinguishers. These protect by stopping the spread of fire to other areas.

What is Fire ?

Fire is the result of a chemical reaction in which a substance combines with oxygen (oxidizes) relatively rapidly. The substance will often change its form and physical state as a result of the heat energy released with emission of light and smoke.

The Importance of Fire Safety

Fire is the single most hazardous event that many people will ever encounter. It endangers lives by inhalation of hot toxic gases and smoke, causing asphyxiation or scorching lungs. Also, it can irreparably damage the whole buildings, complete with their contents. Not only it destroys lives, but it can ruin a business that cannot continue to provide service.

Elements of fire

- Fuel
  Combustible substance in the form of vapour, Liquid or incandescent Solid.
- Heat
  A Source of Ignition sufficient to initiate and propagate the Chemical Reaction of Combustion.
- Oxygen
  Oxygen content in atmospheric Air in sufficient proportion to form a combustible Vapour-Air mixture.

Basic strategy of fire prevention is to control or isolate sources of fuel and heat in order to prevent combustion.
If any of these three is not present in sufficient quantities a fire will not happen.

For a Fire to be self sustaining, the oxidation process should be self sustaining. The Ignition which triggers the oxidation reaction between one tiny bundle of Oxygen and one tiny bundle of fuel must produce enough energy to trigger oxidation between two more tiny bundles of oxygen and fuel. In this manner, the combustion continues like a Chain Reaction

Explosion

In the widest sense, an explosion is an effect produced by the sudden violent expansion of gases. It is a process of rapid physical and/or chemical transformation of a system into mechanical work, accompanied by a change of its potential energy and may also be accompanied by shock waves and/or the disruption of enclosing materials or structures.

Explosion results from –

- Chemical changes such as in the detonation of explosive or the combustion of a flammable gas-air mixture.
- Physical or Mechanical changes such as bursting of pressure vessels.
- Atomic changes

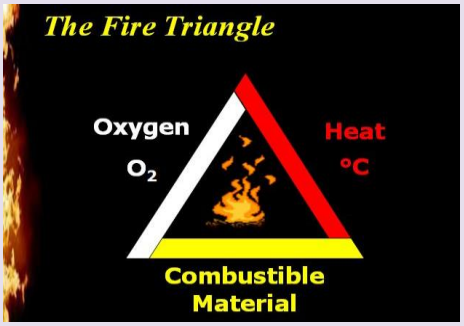
Principle of extinguishing fire

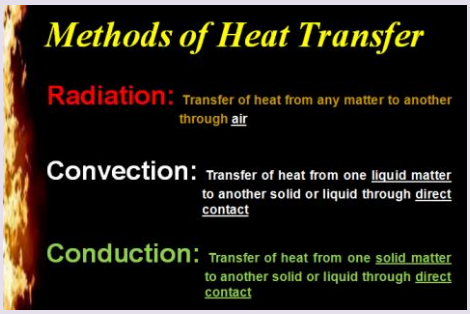
- Starvation - Elimination of fuel
- Smothering - Limiting Oxygen supply
- Cooling - Limiting rise of Temperature*
- Chain inhibition**

*Application of Water
- DIRECT EFFECT - Lowering of temperature
- INDIRECT EFFECT -Smothering and dilution of vaporize due to steam generation

INHIBITION OF CHAIN REACTION BY **DCP ($NaHCO_3$) - WHEN DRY CHEMICAL POWDER DECOMPOSES-
$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$; $Na_2CO_3 \rightarrow Na_2O + CO_2 \rightarrow Na_2O + H_2O \rightarrow 2NaOH$;
$NaOH + H^* \rightarrow Na^* + H_2O$; $NaOH + OH^* \rightarrow NaO^* + H_2O \rightarrow NaO^* + H^* \rightarrow NaOH$; $Na^* + OH^* \rightarrow NaOH$

Fire Theory





Where could fire occur?

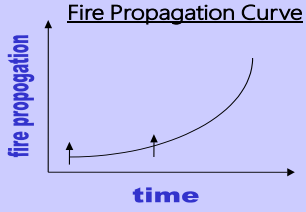
- Electrically energized equipment on site (generators, pumps, welding machines...etc.)
- Gas cylinders & storage areas (Oxygen, Propane, Acetylene...etc.)
- Containers of flammable liquids or Fueling Trucks.
- Construction activities that produce friction, sparks, or naked flame (Grinding, Heating...etc.)
- Vehicles & equipment: cars, excavators, side booms, welding trucks...etc.
- Accumulated waste skips
- Rooms & resting areas.

Prevention Method

- Keep flammable or combustible material in safe distance from activities that produce friction, sparks or naked flame.
- All vehicles, gas cylinders, electrical hand tools, & equipment should be regularly inspected for any defects that might cause fire.
- Do not leave waste accumulated in big quantities.

FIRE EXTINGUISHER

Fire Propagation Curve



Classification of Fire

- Class "A" Fires
- Class "B" Fires
- Class "C" Fires
- Class "D" Fires
- Fires involving Electrical Equipment

Type of Fire	Australia	European	North America
Fires that involve flammable solids such as wood, cloth, rubber, paper, and some types of plastics.	Class A	Class A	Class A
Fires that involve flammable liquids or liquefiable solids such as petrol/gasoline, oil, paint, some waxes & plastics, but **not** cooking fats or oils	Class B	Class B	Class B
Fires that involve flammable gases, such as natural gas, hydrogen, propane, butane	Class C	Class C	
Fires that involve combustible metals, such as sodium, magnesium, and potassium	Class D	Class D	Class D
Fires that involve any of the materials found in Class A and B fires, but with the introduction of an electrical appliances, wiring, or other electrically energized objects in the vicinity of the fire, with a resultant electrical shock risk if a conductive agent is used to control the fire.	Class E1	(Class E) now no longer in the European standards	Class C
Fires involving cooking fats and oils. The high temperature of the oils when on fire far exceeds that of other flammable liquids making normal extinguishing agents ineffective.	Class F	Class F	Class K

Class "A" Fires

Ordinary combustible fire

These are the fires involving Solid combustible materials normally organic in nature (compounds of carbon) in which combustion generally occurs with the formation of glowing amber, where the cooling effect of water is essential for extinguishing the fire. e.g., Wood, Cloth, Paper etc; which leave carbon after combustion

Class "B" Fires

Flammable liquid fire

These are the fires involving flammable Liquids or Liquifiable Solids where blanketing effect is essential for extinguishing the fire. e.g., Petroleum products, Solvents, Paints etc

Class "C" Fires

Flammable gas fire

These are the fires involving gases or Liquified gases under pressure where it is necessary to isolate the burning gas at a fast rate with an inert gas, powder or vaporising liquid for extinguishment. e.g., Fuel Gas, Hydrogen, Liquefied Petroleum Gas etc

Class "D" Fires

Metal fires

The fires that occur in combustible metals generally called Alkali Metals such as Magnesium, Sodium, Titanium etc. are classified under this class. Specialised techniques, extinguishing agents & equipment are required to control such fires.

Electrical fires

According to latest concepts, the electrical fires do not constitute a particular class. Any fire involving an electrical equipment is in fact be a fire of class A, B or C. The normal procedure in such fires is to cut off the electricity and use an extinguishing method appropriate to the burning material. Special extinguishing agents which are non-conductor of electricity and non-damaging to the electrical equipment such as dry chemical powders and carbon di-oxide should be used

The fire risk assessment

Step 1 – identify the hazards.
Step 2 – identify people at risk.
Step 3 – evaluate, remove, reduce and protect from risk.
Step 4 – record, plan, inform, instruct and train.
Step 5 – review.

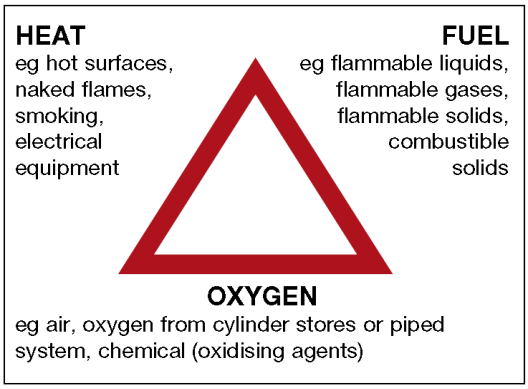
Identify the hazards

The basic principles which follow are relevant to fire risk assessment in all circumstances. However, it is important to note that there will be different things to consider for new builds compared to the refurbishment of an existing building. For a new build, your assessment will include its location and proximity to other buildings, the type of construction materials and methods.

For a fire to start, three things are needed:

- a source of ignition;
- fuel; and
- oxygen.

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



The three elements that combine to start a fire

Identify sources of ignition

identify the potential ignition sources prior to and during the construction process

- smokers' material, e.g. cigarettes, matches and lighters;
- naked flames, e.g. gas- or liquid-fuelled open-flame equipment;
- those deliberately introduced (arson);
- bonfires;
- plant and equipment, e.g. fuel and vehicle exhausts;
- electrical – faulty or misused electrical equipment;

- poor electrical installations, e.g. overloads, heating from bunched cables and/or damaged cable;
- hot processes/hot work, e.g. welding by contractors;
- light fittings and lighting equipment, e.g. temporary lighting, halogen lamps too close to stored products;
- electrical, gas- or oil-fired heaters (fixed or portable), room heaters in temporary office accommodation or welfare cabins;
- heat sources, such as gas, electric, cooking equipment, microwaves;
- friction-generated heat from mechanical equipment such as disc cutters;
- static charge from mechanical equipment;
- use of oxy-fuel equipment;
- spontaneous ignition and self-heating, e.g. oil-soaked rags, paint scrapings; and/or
- lightning and refracted sunlight.

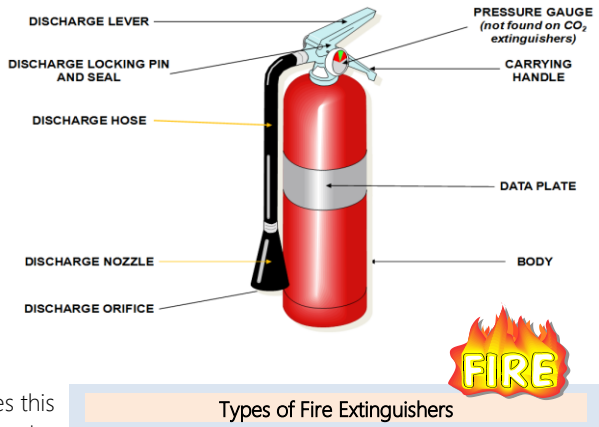
Identify sources of fuel

Anything that burns is fuel for a fire. Many materials which can burn have to be used during construction work. Reducing the quantity of material on site reduces the chances of fire occurring and limits the extent of any fire which should start. Stocks of high fire hazard material should be managed to balance production needs with the need to reduce the risk of fire. Limit the material present at worksites to what is needed for half a day or a single shift and return unused material to the stores when the work is finished. Some of the most common fuels found on site include:

- components of the structure itself such as some composite panels and timber
- stored/in-use building products such as composite panels
- rubbish , waste wood
- flammable liquids such as paints and varnishes
- protective coverings
- scaffold sheeting
- volatile flammable substances such as paints, thinners;
- fuel for portable equipment
- liquefied petroleum gas (LPG), e.g. bitumen boilers, temporary accommodation and similar areas;
- acetylene
- packaging materials
- petrol disc cutters and other portable equipment
- fall-arrest bags.

KNOW FIRE EXTINGUISHER

Fire Extinguisher Anatomy



Identify sources of oxygen

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 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 COSHH/CHIP data sheet) by the manufacturer or supplier who can advise as to their safe use and storage, Examples include:

- oxygen used in welding processes
- oxidising agents

Identify people most at risk

Identify those at risk if there is a fire such as contractors, visiting duty holders and members of the public in nearby premises etc

- those who work alone, e.g. security staff
- people who are in isolated areas, e.g. maintenance staff, staff on cranes and reach trucks
- people who are in unfamiliar with the site, e.g. new sub-contractors or visitors
- people with language difficulties
- young people
- pregnant women
- disabled people
- other people in the vicinity of the premises; and
- those occupying adjacent buildings who may be at risk from radiated heat/fire spread.

Evaluate, remove, reduce and protect from risk

Having identified the hazards in Step 1 and the people at risk in Step 2, action should be taken to reduce the risks to an acceptable level.

Types of Fire Extinguishers

Dry Chemical extinguishers are usually rated for multiple purpose use. They contain an extinguishing agent and use a compressed, non-flammable gas as a propellant.

Halon extinguishers contain a gas that interrupts the chemical reaction that takes place when fuels burn. These types of extinguishers are often used to protect valuable electrical equipment since them leave no residue to clean up. Halon extinguishers have a limited range, usually 4 to 6 feet. The initial application of Halon should be made at the base of the fire, even after the flames have been extinguished.

Water These extinguishers contain water and compressed gas and should only be used on Class A (ordinary combustibles) fires.

Carbon Dioxide (CO_2) extinguishers are most effective on Class B and C (liquids and electrical) fires. Since the gas disperses quickly, these extinguishers are only effective from 3 to 8 feet. The carbon dioxide is stored as a compressed liquid in the extinguisher; as it expands, it cools the surrounding air. The cooling will often cause ice to form around the "horn" where the gas is expelled from the extinguisher. Since the fire could re-ignite, continue to apply the agent even after the fire appears to be out.

As described earlier, depending on the type of Fire, the fire extinguisher should be used. **Incorrect fire extinguisher can make the fire scene worse. It is, therefore, before selecting the fire extinguisher, knowledge of the type of fire is necessary.** To make it easy to understand, pictogram with fire type and general recommendations and instructions are always present on the sticker. Always check the seal, gauze and inspection record sticker. The fire extinguisher should always be in good condition.

- reducing the risk of a fire occurring; and
- reducing the risks to people in the event of a fire.

Reducing the risk of a fire occurring

In general, fires start in one of three ways:

- **accidentally**, when lights are too close to combustibles;
- **by act or omission**, such as when electrical equipment is not properly maintained, or when combustibles are allowed to accumulate near to a heat source, or by storing LPG next to an electric fire or other source of heat; or
- **deliberately**, such as an arson attack involving setting fire to external rubbish skips placed too close to the building.

The early installation of fire mitigation methods such as fire detection and suppression systems will also reduce the risk.

Remove or reduce sources of ignition

There are various ways that you can reduce the risk caused by potential sources of ignition, for example:

- Wherever possible, replace a potential source with a safer alternative, for example, replace naked flame and radiant heaters with fixed convector heaters or other types of heaters with no red element.
- Conduct routine hot works, e.g. steel cutting, in a designated area away from combustible material and the main structure.
- Operate a safe smoking policy – allow smoking only in designated smoking areas and prohibit smoking elsewhere.
- Restrict the movement of and guard portable heating appliances.
- Separate ignition hazards and combustibles, e.g. ensure sufficient clear space between lights and combustibles, and consider building fire-resistant enclosures for hot work processes.
- Control, inspect and monitor ignition hazards, e.g. temporary lighting, halogen lamps, display lighting or lights too close to combustibles.
- Ensure electrical, mechanical and gas equipment is installed, used, maintained and protected in accordance with the manufacturer's instructions, including any equipment located in temporary accommodation.

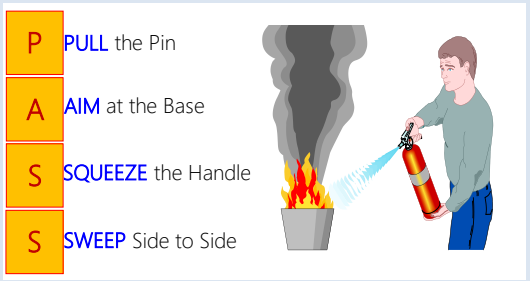
How to USE Fire Extinguisher

Fire Fighting Decision Criteria

- Know department emergency procedures and evacuation routes.
- Know locations of extinguishers in your area and how to use them.
- Always sound the alarm regardless of fire size.
- Avoid smoky conditions.
- Ensure area is evacuated.
- Don't attempt to fight unless:
  - Alarm is sounded.
  - Fire is small and contained.
  - You have safe egress route (can be reached without exposure to fire).
  - Available extinguishers are rated for size and type of fire.
- If, in doubt, EVACUATE !

EXTINGUISHER TYPE	WORKS BY	EFFECTIVE AGAINST
Pressurized Water	Cooling	A
Carbon dioxide	SMOTHERING	B C
Multipurpose DCP	SMOTHERING	A B C
Halon	SMOTHERING	A B C
Combustible Metal	SMOTHERING	D
Wet Chemical	COOLING/ SMOTHERING	A C K

Fighting a FIRE



- Strictly control hot processes/hot work by operating permit-to-work schemes.
- Check all areas where hot work (e.g. welding) has been carried out at regular intervals for 60 minutes after work has finished to ensure that no ignition has taken place and no smouldering or hot materials remain that may cause a fire.
- Ensure that no one carrying out work on gas fittings, which involve exposing pipes that contain or have contained flammable gas, use any source of ignition such as blow-lamps or hot-air guns.
- Take precautions to avoid arson.
- Turn off equipment when it is not attended or being used.
- Take action to avoid any parts of the site, and in particular storage areas, being vulnerable to arson or vandalism.
- Do not permit bonfires on site.

Remove or reduce sources of fuel

There are various ways that you can reduce the risks caused by materials and substances that burn, for example:

- Substitute with less flammable materials.
- Plan to reduce storage of combustible materials (e.g. just-in-time ordering).
- Keep stocks of flammable liquids and gases, in use in open areas, to a minimum.
- Keep flammable liquids and gases which are not in use in dedicated storage areas, externally, where only the appropriate staff are allowed to go, and keep the minimum required for the operation.
- Do not keep flammable solids, liquids and gases together.
- Keep areas containing flammable gases well ventilated, e.g. LPG cylinders should be kept outdoors in a secure cage.
- Remove or treat materials that are provided to protect finished goods.
- Develop a formal system for the control of combustible waste by ensuring that waste materials and rubbish are not allowed to build up and are carefully stored until properly disposed of, particularly at the end of the day, e.g. in lockable metal skips.
- Be aware of the changing flammability of materials as they are used.

Remove or reduce sources of oxygen

You can reduce the potential source of oxygen supplied to a fire by:

- in both new build and refurbishments, closing doors, windows and other openings not required for ventilation, particularly out of working hours;

- eliminating or, if not possible, reducing the amount of oxidising materials and not storing oxidising materials near or within any heat source or flammable materials;
- controlling the use and storage of oxygen cylinders, ensuring that they are not leaking, are not used to 'sweeten' the atmosphere, and that where they are located is adequately ventilated; and
- in the later stages of the project, considering shutting down ventilation systems that are not essential to the function of the premises.

Reducing the risk to people in the event of a fire

Having reduced the risk of a fire occurring to an acceptable level, you now need to consider how you will protect people in the event of a fire. To evaluate the risk to people on your site you will need to understand the way fire can spread. Fire is spread by three methods: convection, conduction and radiation.

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 space. The smoke will pass through any holes or gaps in the walls, ceiling and floor into other parts of the building. The heat from the fire can get trapped in the building and the temperature rises.

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

Radiation – radiation 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.

Smoke produced by a fire also contains toxic gases which are harmful to people. 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 make their escape to a place of total safety before the fire and its effects can trap them in the building or on the site itself.

General fire precautions

In the event of a fire, people must be able to escape from it. The measures which should be in place to allow people to escape are called 'general fire precautions'. Such as

1)escape routes and fire exits; 2)fire-fighting equipment; 3)fire detection; 4)raising the alarm; 5)making emergency plans; and 6)limiting the spread of fire (compartmentation).

Record, plan, inform, instruct and train

In Step 4 there are four further elements of the risk assessment you should focus on to address the management of fire safety on site. In some sites with simple layouts this could be done as part of the day-to-day management. However, as the sites get larger it may be necessary for a formal structure and written policy to be developed.

Recording the significant findings and action taken

If organisation employs five or more people then it must record the significant findings of fire risk assessment and the actions taken. Significant findings should include details about the:

- fire hazards you have identified in Step 1 (you do not need to include trivial things like a small tin of solvent-based glue);
- actions you have taken or will take to remove or reduce the chance of a fire occurring (preventive measures);
- people who may be at risk, including those who may be affected in adjacent premises;
- actions you have taken or will take to reduce the risk to people from the spread of fire and smoke;
- general fire precautions, ie escape routes and fire exits, fire-fighting equipment and raising the alarm;
- actions people need to take in case of fire, including details of any people nominated to carry out a particular function (your emergency plan); and
- information, instruction and training you have identified that people need and how it will be given.
- record discussions with staff or staff representatives (including trade unions).
- The record could take the form of a simple list which may be supported by a simple plan of the site.

The findings of your fire risk assessment will help you to develop your emergency plan; the instruction, information and training you need to provide; the co-operation and co-ordination arrangements you may need to have with other responsible people; and the arrangements for maintenance and testing of the fire precautions.

Emergency plans

Emergency plan should be based on the outcome of your fire risk assessment and be available for workers, contractors, sub-contractors and their representatives and the enforcing authority. They should be produced before the work begins and any control measures identified should be in place from the start of the work.

This guidance concentrates on fire. However, problems, such as flooding in excavations, tunnels, work near the sea or rivers, waterworks etc, or risk from asphyxiation or toxic gases. These should be integrated within fire procedures.)

The purpose of an emergency plan is to make sure that the physical measures will work effectively if they are ever needed and to ensure that the people of all languages.

Inform, instruct, co-operate and co-ordinate

Give clear and relevant information and appropriate instructions to people on your site, such as sub-contractors (and their employers) and visitors, about how to prevent fires and what they should do if there is a fire.

Review

Monitor and review what is going to be implemented of the fire risk assessment to assess how effectively the risk is being controlled. These plans should be reviewed and revised regularly/ periodically and or in case of significant incident or accident or if regulatory changes occur.

Because sites change rapidly, and often the workforce is transient, you need to ensure the risk assessment reflects these changes and the control measures necessary.

Reasons for review could include:

- changes to work activities or the way that you organise them, including the introduction of new equipment;
- progression through the various stages of construction, e.g. alterations to the building, including the internal layout;
- the introduction, change of use or increase in the storage of hazardous substances;
- the failure of fire precautions, e.g. fire-detection and alarm systems;
- significant changes to types and quantities and/or methods of storage of goods; and
- a significant increase in the number of people present.

Reducing ignition sources

- **Smoking-** a 'no smoking' policy must be established. Any designated safe open air locations where smoking is allowed should be of a low fire risk design, away from any combustible or flammable materials and provided with metal ashtrays filled with sand.
- **Plant and equipment-**Plant and equipment should be appropriate for the task and consideration should be given to the area where it is sited (e.g. it may be acceptable to use a small generator in an open, well-ventilated building constructed of non-combustible materials; however, this would not be appropriate in a basement or enclosed space or an unprotected, framed construction such as timber). Consideration should also be given to the storage of plant and equipment in relation to fire risk. Select plant, both electrical and engine driven, to match the demands placed upon it to prevent overheating during use, especially in dusty conditions.
- **Operating and refueling-** (especially with petrol) should not take place within a confined space; no refuelling on scaffold or escape routes, it should be in the open air or in well-ventilated spaces away from ignition sources. Bulk flammable liquid storage tanks should be bunded to current standards.

Use of oxy-fuel equipment

- Workers should be competent in the use of oxy-fuel equipment, understand and follow appropriate work practices
- Provision and maintenance of the correct equipment are key factors in preventing incidents The safe use of compressed gases in welding, flame cutting and allied processes must be taught
- To avoid confusion hoses may be colour coded as:

  blue – oxygen; red – acetylene; orange – propane.
- Non-return valves at the torch (blowpipe) inlet and flashback arresters at the pressure outlet from the gas cylinders should be provided on both gas lines. All such devices should be to an appropriate standard,
- Make sure that oil or grease do not contaminate the oxygen supply. Only use components that have been specially cleaned and supplied for oxygen use.
- Always check equipment visually for damage before use, especially the hoses. Any badly damaged or suspect hoses should be discarded from use. When you have assembled the equipment, always check for leaks by applying a soap solution around joints and watching for bubbles.
- Gas cylinders should be secured in an upright position. Hose length should be kept to a minimum. This reduces the likelihood of damage and should help to ensure that the hose is not damaged by the hot work.
- Nominally empty drums should not be used as supports for hot work activities.

Permit-to-work (PTW) systems

All hot work generating heat sparks or flames can cause a fire. To avoid this, PTW systems should be considered. Where hot work is not carried out often, and where the risk of fire is low, the need for formal systems of management control is less. However, as the amount of hot work and the risks associated with it increases, the need for formal PTW systems increases. They are particularly useful where there are numerous hot work operations taking place and where there is a lot of combustible material present, both incidentally and as part of the building structure.

- PTW systems should normally include:
- the location and nature of the hot work intended
- the proposed time and duration of the work
- the limits of time for which the permit is valid
- the person in direct control of the work.

Electrical installations

Electrical installations, especially temporary ones, should be of sufficient capacity for the intended use and designed, installed, inspected and maintained by competent personnel. Do not allow ad hoc additions or alterations to the electrical installation by personnel who are not competent.

- Some common electrical faults posing fire risks include:
- use of flat twin and earth cable as extension leads instead of suitable flexible cable
- overloading of sockets in site accommodation
- cable laid in or near combustible material, frequently in roof and ceiling voids

- accumulation of rubbish against distribution boards poses similar fire risks and often occurs when installations are located in quiet parts of the site
- intentional defeating of safety devices, such as fuses or circuit breakers
- mechanical damage to cables, often as a result of inappropriate routeing of cables;
- makeshift cable joints made without correct proprietary connectors; and/or
- use of non heat-resistant glass or broken glass cover over a halogen lamp (poor heat-resisting glass covers have been known to ignite flammable vapours being emitted from a freshly applied solvent-based covering laid on to floors).
- The proper use of electrical safety devices, such as residual current devices (RCDs), can reduce the risks of fire arising from electrical faults.
- In order to design and install a system which is safe, with adequate capacity, those responsible need to be informed about its likely use. Electrical systems need to be periodically checked to ensure that they remain safe and free from damage or deterioration.
- Electrical equipment should meet standards that reflect the adverse conditions on most construction sites.

Bonfires: The burning of any vegetation or rubbish on site should be avoided unless absolutely necessary, and should only be considered in very limited situations such as site clearance for major road construction.

Arson and site security

Trespassers on site may deliberately or accidentally start a fire. Arson is a real, substantial problem and risk on all sites, particularly where there are trespassers. Measures should be in place to prevent unauthorised access. Care is needed to ensure that no gaps develop in the fencing/hoarding around the site.

Reducing potential fuel sources

Dangerous substances can put people's safety at risk from fire and explosion.

Reducing the amount of combustible material

- Where combustible or flammable materials have to be used, select the least flammable alternatives. The amount of material kept on site, which can burn, should be minimised. The need to store such material varies greatly during the life of a site, but try to avoid stockpiling it unless it really is necessary

The changing flammability of materials as they are used

- Construction work can alter the flammability of substances, including nominally flame-retardant ones. For instance, when worked on, solid materials (even nominally fire-resisting ones) produce dust, crumbs or other fine material which are always more easily ignited than the bulk material. Remember this when planning construction fire precautions, especially when hot work is used.

General requirements for storage of all combustible materials

- Ideally, combustible materials need to be stored outside buildings under construction, especially volatile flammable materials such as LPG. If combustible materials are stored inside buildings, they need to be kept in an area where the safety of people (on and adjacent to the site) is not threatened in the case of a fire. For example, do not put paint stores next to emergency exits or under any means of escape, e.g. steps/staircases.
- Access to stores should be controlled so that material does not become dispersed haphazardly around the site.
- If storage outside the structure is not possible, internal stores need to be arranged to limit the spread of fire. Internal stores, especially in more enclosed buildings, may need to be separated from the rest of the structure by a partition providing at least 30 minutes' fire resistance. Good quality plasterboard will usually achieve this and can be very useful for constructing small internal stores. Doors should be fire resisting and self-closing.

Storage of more volatile flammable materials

Extra precautions are needed with highly flammable liquids with flashpoints below 32ºC, e.g. with many solvents, petrol, adhesives, LPG, flammable gas and oxygen cylinders, especially when stored internally

- Good ventilation is needed to prevent dangerous levels of gases or vapours accumulating in internal stores. High and low openings in the external wall help to achieve this. The openings should not ventilate into the surrounding structure. Openings representing 1% of the total floor and wall area are sufficient for flammable liquid storage. For flammable gas and oxygen cylinders, openings representing 2.5% of the total floor and wall area are usually sufficient.
- Locate external stores in the open air, in a well-ventilated area that is shaded from the sun.

Handling more volatile flammable substances

- Flammable liquids, especially highly flammable liquids, need careful handling. Practices to limit the likelihood of spills and the release of flammable vapour concentrations are required. In particular:
- provide drip trays to contain spillage during dispensing and decanting
- carry out operations in well-ventilated areas
- use proper handling aids when dispensing from large containers
- keep flammable liquids in secure closed-top containers during conveyance
- dispose of contaminated rags safely – containers should be of metal construction and be suitably covered with a metal lid; and
- ensure that any clothing becoming soaked in flammable liquids is removed and replaced with fresh clothing.

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