NEBOSH International Diploma in Occupational Health & Safety

UNIT IC

INTERNATIONAL WORKPLACE AND WORK EQUIPMENT SAFETY

ELEMENT IC3: WORKPLACE FIRE RISK ASSESSMENT

SAMPLE MATERIAL

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RRC TRAINING

Identification of Hazards and The Assessment of Risk From Fire

Key Information

- Fire risk assessment assesses where and why a fire could start and what harm it would cause to those in and around the premises. Once this is established, measures can be put in place to prevent such fires.
- The five steps to fire risk assessment involve:
  - Identifying fire hazards to establish how a fire might start.
  - Identifying people at risk and those especially at risk.
  - Evaluating the risk of fire breaking out and people being harmed as a result and removing or reducing the risk by the use of protective measures.
  - Recording the significant findings, implement appropriate emergency plans, and provide information, instruction and training.
  - Regularly reviewing the assessment.

Fire Hazards and Assessment of Risk

Fire risk assessment can be defined as 'an organised and methodical look at premises, the activities carried on there, and the likelihood that a fire could start and cause harm to those in and around the premises'.

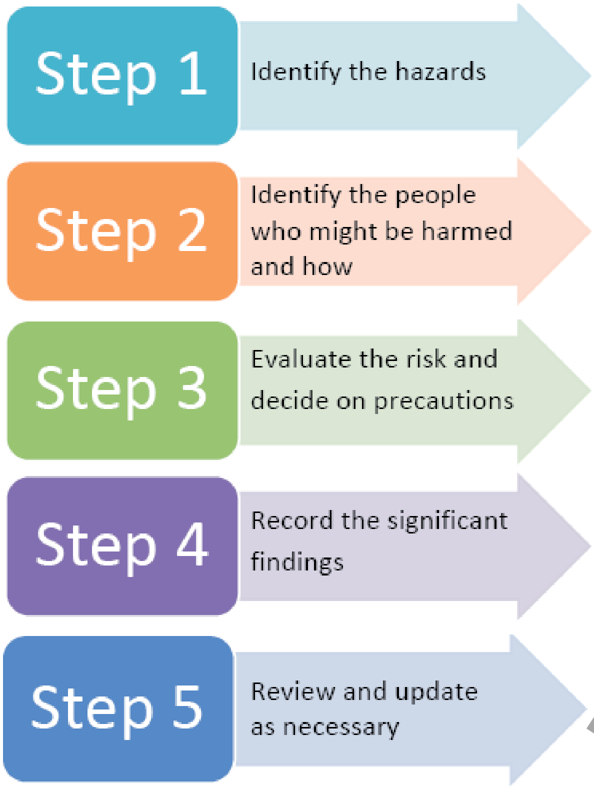
Whilst there are no fixed rules about how a fire risk assessment should be conducted, it is important to adopt a structured approach that ensures all fire hazards and associated risks are taken into account.

Topic Focus

- **"Risk" in relation to the occurrence of fire in a workplace depends on:**
  - The likelihood of a fire occurring.
  - Its potential consequences for the safety of persons such as death, injury or ill-health.
- **The types of physical harm that could be caused to persons by a workplace fire include:**
  - Smoke inhalation, causing burning to the lungs and triggering conditions such as asthma.
  - Suffocation or respiratory difficulties caused by depletion of oxygen.
  - Poisoning by inhalation of toxic gases and other combustion products.
  - Burning by heat, flames or explosion.
  - Injury from falling or collapsing structures.
  - Falls from a height or on the same level caused by panicking and crushing.
  - Injury from broken and flying glass.
  - Mental or physical trauma.
  - Death.

Five Steps to Fire Risk Assessment

The following five-step approach is commonly used in risk assessment.



Five Steps to Fire Risk Assessment

Step 1: Identify Fire Hazards

For fire to occur, it is necessary to have three elements - fuel, heat (or ignition) and oxygen - come together at the same time, in the correct amount. This is known as the fire triangle, which we considered in Element IC2.

Identifying the fire hazards means looking for all the sources of ignition, fuel and oxygen that together might cause fire.

Step 2: Identify People at Risk

It is important to consider anyone who may be affected in the event of a fire, not just workers in the immediate area. Maintenance staff, contractors, other workers and people present outside normal working hours (such as cleaners and security guards) must also be taken into account.

Where visitors and members of the public, etc. have access to the premises they must also be included in the assessment.

Additionally, any individuals or groups who may be particularly at risk must be considered. For example, young or inexperienced workers, people with mobility or sensory impairment, lone workers and pregnant workers, etc. may all be at greater risk in the event of a fire.

Step 3: Evaluate, Remove, Reduce and Protect from Risk

This is the process of evaluating the risk of:

- fire breaking out; and, if a fire does occur,
- people being harmed as a result.

The risk of fire breaking out can be removed or reduced by the use of appropriate **preventive measures**, such as:

- Effective control of ignition sources.
- Appropriate storage of flammable materials.
- Good housekeeping.
- Maintenance and inspection of equipment.
- Providing adequate information and training, etc.

The risk of people being harmed in the event that a fire does occur can be removed or reduced by the use of appropriate **protective measures**, such as the provision of:

- Automatic detection and alarm systems.
- Adequate means of escape (including signage and emergency lighting).
- Fixed and portable fire-fighting equipment.
- Appropriate emergency procedures.
- Information and training, etc.

As it is rarely possible to entirely eliminate risk, it is important to ensure that remaining risks are controlled to an acceptable level.

Step 4: Record, Plan, Inform, Instruct and Train

The significant findings of the assessment, e.g. the fire hazards identified, individuals or groups at risk, the level of risk, and the actions taken to remove and/or reduce the risks must be **recorded**.

Appropriate **emergency plans** should be developed and implemented.

(Note that evacuation procedures should be practised regularly to ensure that all employees are familiar with the arrangements.)

Provide appropriate **information and instruction** to relevant persons on:

- Actions required to prevent fires.
- Actions required in the event of a fire.

Provide appropriate **training** for employees, in particular for those who may have specific duties in relation to fire prevention activities (e.g. conducting workplace inspections or checks on equipment, etc.) or in the event of a fire occurring (e.g. Fire Marshals).

Step 5: Review

The way we work is constantly changing – often as a result of new, or modifications to existing, equipment, buildings, procedures, products and processes, etc.

As such, it is important to continue to be vigilant about new, or changed, fire hazards and risks and to review the fire risk assessment regularly.

How often "regularly" means in practice will depend on the extent of the risks and the degree of change but, as a guide, the assessment should be reviewed:

- Whenever there is reason to suspect it is no longer valid.
- After a significant or major incident.
- If there has been a significant change in circumstances in the workplace.
- Periodically, with the frequency depending on the nature of the business and the fire risks.

In all cases, the assessment should identify the hazards, assess the level of risk and consider how the risk may be minimised.

The risk assessment should be extensive and detailed enough to enable a responsible person to identify and prioritise the preventive and protective measures required to protect relevant persons from harm.

Revision Questions

1. Describe the types of physical harm that could be caused to persons by a workplace fire.
2. Explain the method for carrying out a fire risk assessment.

(Suggested Answers are at the end of the book.)

Fire Detection and Alarm Systems and Procedures

Key Information

- All buildings should have provision for detecting fire and sounding an alarm in the event of fire.
- The type of detection/alarm system used will be determined by the type of occupancy and escape strategy.
- A fire detector identifies physical changes in the protected environment indicative of the development of a fire condition such as combustion products, visible smoke, flame/illumination or temperature rise.
- The types of detector designed to identify these conditions are:
  – Ionisation smoke detectors.
  – Optical detectors.
  – Radiation detectors.
  – Heat detectors.
- Manual alarm systems are suitable for small workplaces and include rotary gongs, hand strikers, handbells, whistles and air-horns.
- An automatic fire alarm system may be designed to respond to heat, smoke and the products of combustion and flames and may incorporate a facility for additional functions, such as closing down ventilation or air conditioning plant, or activating automatic door releases.

Common Fire Detection and Alarm Systems and Procedures

In order to determine the most suitable type of detection/alarm system for a particular building, it is necessary to determine the type of occupancy and escape strategy.

Where the escape strategy is based on simultaneous evacuation, activation of a manual call point or detector should cause all fire alarm sounders to operate. Where the escape strategy is based on phased evacuation, a staged alarm system might be more appropriate (i.e. one tone for alert, another for evacuation). This system is used extensively in large organisations (college and university campuses, for example) where full evacuation is often not necessary.

Fire-Warning Signals

Design and Application of Fire Detection and Alarm Systems

All buildings should have provision for detecting fire. When a fire is detected, the following arrangements should be in place:

- Sounding an alarm in the event of fire.
- Evacuating staff to safe fire assembly points using means of escape routes.
- Fighting the fire.

Regular tests of an alarm system serve to check the circuits and to familiarise staff with the call note. The fire-warning signal must be distinct from other signals in use.

When selecting the method of alarm, it's important to ensure it will be heard in all parts of the building (the toilets, for example). Fitting fire doors to a building cuts down the distances over which call bells are heard, and may mean further bells must be fitted or noise levels raised.

A fire alarm can be raised automatically by a detection system or manually by a person in the affected building. We shall examine later the means available to somebody in the affected area for raising an alarm. These will generally be either manual or manual/electric, not forgetting that an alarm can always be raised by shouting.

Principal Components of Alarm Systems – Detection and Signalling

A fire detector identifies one or more physical changes in the protected environment indicative of the development of a fire condition. Usually mounted on ceilings or in air ducts, detectors are activated mainly by smoke or heat/light radiation. Such conditions can be readily identified:

- After ignition has occurred and the invisible products of combustion are released.
- When visible smoke is produced.
- When the fire produces flame and a degree of illumination.
- When the temperature in the vicinity of the fire rises rapidly or reaches a predetermined value.

The types of detector designed to operate at one of these particular stages are:

- Ionisation smoke detectors.
- Optical detectors.
- Radiation detectors.
- Heat detectors.

The most common types of detector system in use at present are those actuated by smoke and those actuated by heat.

Smoke Detector

The final choice is based on the risk to be protected against and the individual circumstances of each case (see the following table).

Automatic Fire Detectors

Type	Suitability
Smoke	
Ionisation Sensitive in the early stages of a fire when smoke particles are small. Sensitivity tends to drop as particles grow in size.	Areas having a controlled environment, i.e. free from airborne dust, etc., and generally housing complex equipment of high intrinsic value, e.g. computer installations.
Optical Most effective in situations where the protected risk is likely to give rise to dense smoke (i.e. large particles).	Normally used as point detectors but have been developed to form zone sampling systems by monitoring air samples drawn through tubes.
Radiation	
Infra-red Rapid detection because of almost instantaneous transmission of radiation to the detector head. This is dependent, however, on the detector having a clear 'view' of all parts of the protected area.	Warehouses or storage areas, etc. Detectors are available which can scan large open areas and will respond only to the distinctive flame flicker. Can be used to detect certain chemical fires.
Ultra-violet As for infra-red.	Ultra-violet detectors tend to be used mainly for specialised purposes.
Heat	
Fusible alloys Alloys will need replacing each time the detector operates.	Areas of general risk where vapour and particles are normally present. Cost is relatively low compared to other types of detector.
Expansion of metal, air and liquid Generally self-resetting.	Both 'fixed-temperature' and 'rate-of-rise' types are equally efficient, but fixed-temperature types are preferred in areas where a rapid rise in temperature is a likely result of the normal work processes.
Electrical effect Not widely installed. Some specialist use.	
Note for all types of heat detectors May be used as point or line detectors and are designed to operate either at a pre-selected temperature ('fixed-temperature' type) or on a rapid rise in temperature ('rate-of-rise' type) or both. With all heat detectors (particularly fixed-temp types), 'thermal lag' needs to be considered when choosing the operating temperature.	'Rate-of-rise' types will compensate for gradual rises in ambient temperature and are more efficient than the 'fixed-temperature' type in low-temperature situations. ('Rate-of-rise' detectors generally incorporate a fixed-temperature device.)

Not all detectors will be equally sensitive in every possible situation. In some cases a combination of different detectors may be required. For example:

- Smoke and heat detectors are suitable for most buildings.
- Radiation detectors are particularly useful for high-roofed buildings, e.g. warehouses, and situations in which clean-burning flammable liquids are kept.
- Laser infra-red beam detectors appear to have advantages where there are tall compartments or long cable tunnels.

Such generalisations should be considered together with the nature of the risk to be protected in order to establish:

- The reliability required. A more robust detector is necessary in an industrial setting than in a hotel, for example. Dusty or damp atmospheres will affect some detectors more than others.
- The sensitivity required. It would obviously be undesirable to install a smoke detector set at high sensitivity in a busy kitchen (or similar conditions).
- The location of detectors. The detectors should be located so they are in the best possible position to perform their function.

All alarm systems must be maintained and tested regularly, and the results recorded. Any faults discovered must be rectified and the system rechecked.

All staff must know how to raise the alarm and what to do when the fire alarm sounds.

Staff with hearing or other physical disabilities must be accommodated within an evacuation plan (e.g. people in wheelchairs cannot use stairs, as other people would, when a lift is inactivated). Emergency lights or vibrating devices may be used in addition to bells or sirens.

Manual and Automatic Systems

Manual Systems

Manual systems are suitable for small workplaces.

The purely manual means for raising an alarm involve the use of the following basic devices:

- Rotary gongs, which are sounded by turning a handle around the rim of the gong.
- Hand strikers, e.g. iron triangles suspended from a wall accompanied by a metal bar which is used to strike the triangle.
- Handbells.
- Whistles.
- Air horns.

These devices are normally found on the walls of corridors, entrance halls and staircase landings, in a situation where they are readily available to anyone who may need to raise an alarm. While they give an alarm over a limited area, operation of one of them is rarely adequate to give a general alarm throughout the premises. As a person is required to operate them, a continuous alarm cannot be guaranteed for as long as may be necessary.

Manual/Electric Systems

These are systems which, although set in motion manually, operate as part of an electrical alarm circuit. The call points in a manual/electric system are invariably small wall-mounted boxes, which are designed to operate either:

- Automatically when the glass front is broken.
- When the glass front is broken and the button is pressed.

Most available models are designed to operate immediately when the glass front is broken.

In order to raise an alarm, it is possible to use facilities which may already be installed in a building for other purposes, e.g. a telephone or public address system. With automatic telephone systems, arrangements can be made for a particular dialling code to be reserved for reporting a fire to a person responsible for calling the fire brigade and sounding the general alarm. Alternatively, it can be arranged so that use of the code automatically sounds the general alarm.

Automatic Systems

An automatic fire alarm system may be designed to respond to heat, smoke and the products of combustion and flames. Although the system will give warning of a fire, it cannot take action to contain it. However, some more elaborate designs do incorporate a facility for additional functions, such as closing down ventilation or air conditioning plant, or activating automatic door releases.

Revision Questions

3. Name the four types of detector commonly used in buildings.
4. Explain the benefits of regular testing of fire alarms.
5. For what types of workplaces are manual alarm systems suitable?

(Suggested Answers are at the end of the book.)

Fixed and Portable Fire-Fighting Equipment

Key Information

- Fixed ('passive') fire-fighting systems fall into four main categories:
  - Sprinklers.
  - Drenchers.
  - Total flood systems.
  - Deluge systems.
- The main types of extinguishing agent used in fixed installations are:
  - Water.
  - Foam.
  - Carbon dioxide.
  - Halon.
  - Dry powder.
- A common classification system for fires is as follows and each type may be extinguished by the following agents:

CLASS	DESCRIPTION	EXTINGUISHING AGENT
A	Fires involving mainly **organic solids** (wood, paper, plastics, etc.).	Water Foam Dry powder (ABC)
B	Fires involving flammable **liquids** (such as petrol, paint, oils) and liquefiable solids (such as fats, waxes, greases but excluding cooking oils/fats).	Dry powder Specialist foam CO_2
C	Fires involving **gases** (such as butane, propane).	Turn off the supply Liquid spills may be controlled by dry powder
D	Fires involving certain **metals** (such as sodium, magnesium, aluminium).	Special powders (m28 or l2) Dry sand or earth Graphite powder Sodium carbonate and salt and/or talc
F	Fires involving commercial deep fat/oil fryers.	Specialist 'wet chemical' Fire blanket (minor fire only)

- Extinguishing a fire is based on removing one or more sides of the fire triangle:
  - Removing the fuel by starvation.
  - Removing the oxygen by smothering.
  - Removing the heat by cooling.
- Fire-fighting equipment should be sited in an easily seen and reached position, regularly inspected and maintained, and persons required to use it suitably trained.
- Environmental damage can result from contaminated fire-fighting water run-off and sites should consider the polluting effects of fire in their emergency plans.

Fixed Fire-Fighting Systems and Equipment - Design and Application

In certain establishments, fixed fire-fighting systems are installed. Fixed (sometimes referred to as 'passive') fire-fighting systems fall into four main categories. Those systems dedicated to the protection of life have a higher specification than those dedicated to property.

The four categories are:

- **Sprinklers** are characterised by independent, sealed sprinkler heads. Only the discharge heads in the immediate vicinity of the fire rupture, so that water damage is limited. They are widely used and have a rating ranging from LH (light hazard) through OH (ordinary hazard) to HH (high hazard).
- **Drenchers** are designed to protect adjacent buildings or facilities from the effects of radiated heat and flying brands from a fire. They provide a curtain of water over parts of a building (or openings). They are commonly used to protect large gas storage tanks.
- **Total flood systems** render the atmosphere inert by dilution or flame interference (CO_2 or halon). They are dangerous to occupants and therefore a safe system (manual lock-off) must be employed. There is also a danger of re-ignition when opened up.
- **Deluge systems** have all the discharge heads open, but the flow of extinguishing agent is controlled by a single deluge valve (which may be activated by a pilot sprinkler system). They are often used for high-risk cases such as flammable liquid storage tanks.

Fixed fire-fighting systems consist primarily of pipework which delivers and releases an extinguishing medium when activated directly by heat or indirectly by the warning/alarm system. Such systems are likely to be installed in large buildings where there is a high risk, where access is difficult, or where equipment or stock is valuable.

The main types of extinguishing agent used in fixed installations are:

- **Water** – generally used in sprinkler systems.
- **Foam** – includes either low expansion foam, which is suitable for flammable liquid fires, or high expansion foam, which is especially useful in inaccessible areas, e.g. cable tunnels and basements.
- **Carbon dioxide** – suitable for hazardous plant, e.g. electrical equipment, computer areas, control rooms and sensitive materials.
- **Halon** – used in similar situations to carbon dioxide. However it is now not used often, because its use is strictly controlled (limited to specialist military and aerospace uses). (Alternatives to halon include water mist.)
- **Dry powder** – suitable for flammable liquids, electrical equipment, or situations where water damage must be kept to a minimum (dry powder is not suitable where re-ignition may occur).

For water-based systems, a supply of water is clearly required. There are two basic systems:

- **Wet riser** systems remain filled with water at fire mains pressure. Such systems are subject to frost damage in unprotected areas and/or water leaks.
- With **dry risers**, water is only available at the outlets when the system is connected either to the fire mains or from a pumped reservoir or supply. These systems are not subject to frost damage, so they may be used in cold stores.

Wet and dry riser sprinkler systems have independent, sealed sprinkler heads. The sprinkler heads are designed to open under fire conditions (e.g. through fusible solder links). Water is only directed to those heads which have been activated – since they are all independent.

Deluge systems are designed for high-risk areas and consist of pipework with open heads, with the water being held back by a deluge valve. A fire-detection device trips the deluge valve and water is discharged from every head.

Classification of Fires

A common classification system for fires is given below:

CLASS A	Fires involving mainly organic solids (wood, paper, plastics, etc.).
CLASS B	Fires involving flammable liquids (such as petrol, paint, oils) and liquefiable solids (such as fats, waxes, greases but excluding cooking oils/fats).
CLASS C	Fires involving gases (such as butane, propane).
CLASS D	Fires involving certain metals (such as sodium, magnesium, aluminium).
CLASS F	Fires involving commercial deep fat/oil fryers.

Classification of Fires

Portable Fire-Fighting Equipment

The range of fire extinguishers (their size, colour, method of operation and claims for performance) is so great that it can be confusing. The equipment which the average person will grab in the event of fire should therefore be **suitably located** and **suitable for the risk**.

The problems arise when more than one type of risk may be encountered and the person, who is operating under pressure, is faced with a choice of extinguishers. The wrong choice could render their efforts wasted or even expose the person to danger.

Firstly we will identify the **nature of the risk** and the choices of agent which are available.

The Nature of Risk				
Fire Class	**Description**		**Examples**	**Extinguishing Agents**
A	**Solid materials** Usually of organic origin (containing carbonbased compounds)		Wood, paper, fibres, rubber	Water Foam Dry powder (ABC)
B	**Flammable liquids and liquefied solids**	Those miscible with water (capable of being mixed)	Alcohol, acetone, methyl acetate	Dry powder Specialist foam CO_2
		Those immiscible with water	Petrol, diesel, oil, fats and waxes	Dry powder Foam
C	**Gases and liquefied gases**		Natural gas, liquefied petroleum gases (butane, propane)	Turn off the supply Liquid spills may be controlled by dry powder
D	**Flammable metals**		Potassium, sodium, magnesium, titanium	Special powders (m28 or l2) Dry sand or earth Graphite powder Sodium carbonate and salt and/or talc
F	**High-temperature cooking oils**		-	Specialist 'wet chemical' Fire blanket (minor fire only)

Gas fires can be difficult to deal with. Whilst dry powder and carbon dioxide may be used to knock the flame down, there is a risk of a build-up of gas if it cannot be turned off. In some situations, it may be preferable to allow the fire to continue and to call the Fire Brigade.

You will notice that electrical fires are not listed; this is because electricity is not a fuel – it will not burn. However, it can cause fires and it can be present in fires, so we have to consider it when fighting fires.

Extinguishing Media and Mode of Action

Extinguishing a fire is based on removing one or more sides of the fire triangle:

- **Removing the Fuel**

  Extinction by this process is known as **starvation**. This can be achieved by taking the fuel away from the fire, taking the fire away from the fuel and/or reducing the quantity or bulk of fuel available. Materials may therefore be moved away from the fire (to a distance sufficient to ensure that they will not be ignited by any continuing radiant heat) or a gas supply may be turned off.

- **Removing the Oxygen**

  Extinction by this process is known as **smothering**. This can be achieved by either allowing the fire to consume all the available oxygen, whilst preventing the inward flow of any more oxygen, or adding an inert gas to the mixture. The most usual method of smothering is by use of a blanket of foam or a fire blanket.

- **Removing the Heat**

  Extinction by this process is known as **cooling**. Cooling with water is the most common means of fighting a fire and this has a dual effect:

  – Absorbing the heat and thereby reducing the heat input into the fire.

  – Reducing the oxygen input, through the blanketing effect of the steam produced.

Although water is the most common medium used to fight fires, it is by no means either the only substance or the most suitable one. Indeed, using water on certain types of fire can make the situation worse.

The main different types of extinguishing media are described below and you should note their application to the classification of different types of fire.

Water

Water, applied as a pressurised jet or a spray, is the most effective means of extinguishing class A fires. It may also be used, as a spray, on class B fires involving liquids and liquefied solids which are miscible (capable of mixing) with water, such as methanol, acetone and acetic acid.