Unit 1 Introduction to Fire Safety

Learning Outcomes

By the end of this unit the learner will be able to:

- ✓ Understand the most important fundamentals of fire chemistry
- ✓ Choose the appropriate type of fire extinguisher for different types of fires
- ✓ Put effective measures in place to prevent fires from occurring in the workplace

Unit 1

Introduction to Fire Safety

What is Fire?

Fire Triangle

Three things are required to start a fire:

- A source of heat/ignition;
- Fuel; and
- Oxygen.

A fire cannot start if any of these are missing. As a result, taking precautions to prevent the three from colliding will reduce the likelihood of a fire.

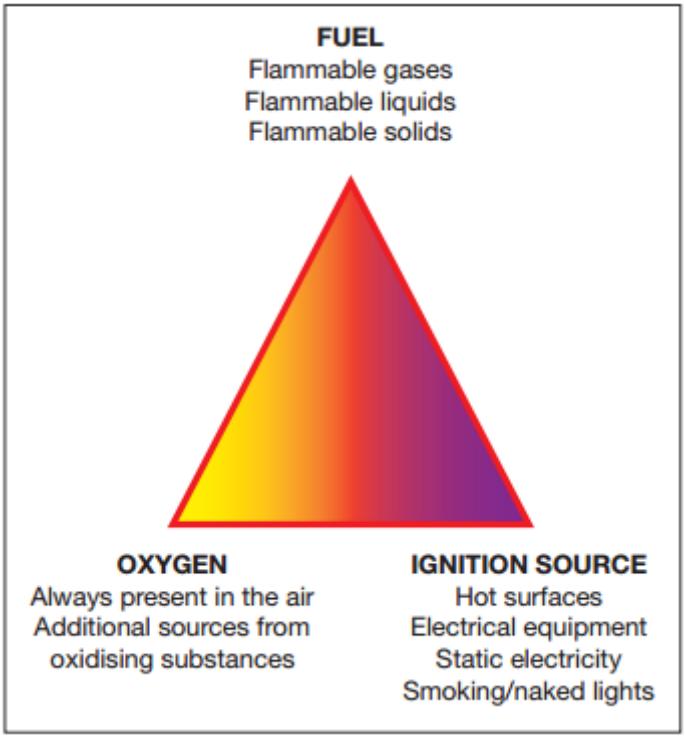

Figure 1.1: The Fire Triangle

Fundamentals of Fire Chemistry

The fire triangle (also known as the combustion triangle) is a simple model for understanding the chemical reaction that must occur in order to create a fire. It is commonly taught in schools. It is made up of three components: fuel, heat, and oxygen, all of which must be present for a fire to start. It also demonstrates how these ingredients are interdependent in the creation and maintenance of a fire, and teaches us that removing any one of them will prevent or extinguish the fire.

The fire triangle, which examines the dynamics of fire, is a common form of fire safety training. It is much easier to grasp the need for, and details of, fundamental fire regulations by looking at and understanding this in greater depth – so let's get back to basics...

Fuel

There must be a material to burn in order for a fire to start, and this is referred to as the fuel. Any combustible material, such as paper, oils, wood, gases, fabrics, liquids, plastics, and rubber, can be used as fuel. The moisture content, size, shape, and quantity of a fire's fuel are usually characteristics that determine how easily the fuel will burn and at what temperature.

Heat/Ignition

Heat must be present in addition to a fuel source for ignition to take place. All flammable materials emit flammable vapours that ignite when heat is applied. Heat is also responsible for the spread and maintenance of fire because it removes moisture from nearby fuel, warms the surrounding area, and pre-heats fuel in its path, making it easier for it to travel and develop.

Oxygen

Fires require oxygen in addition to fuel and heat to stay alight. The oxidising agent in the chemical reaction is ambient air, which contains approximately 21% oxygen and is used because most fires only require at least 16% oxygen to burn. When the fuel burns, it reacts with the oxygen in the air to produce heat and combustion.

Extinction of the fire

One of the three elements of the fire triangle must be removed to put out a fire. So, if a fire runs out of fuel, it will smoulder; if you can cool it down, it will lose heat and go out; and if you take away the oxygen, it will suffocate. As a result, attempts to put out a fire and also to prevent one are based on these principles. Fire blankets, for example, put out a fire by removing oxygen and thus suppressing it. Similarly, fire extinguishers are designed to eliminate one of the three elements – for example, water fire extinguishers cool the fire and remove any heat.

Fire prevention methods are also developed in relation to the chemical reaction that occurs when a fire occurs, using the same codes of practise. It's critical to take precautions like putting flammable liquids away and making sure piles of paper or fabric aren't left near any potential heat sources.

The frequency of fires and the damage they cause can be significantly reduced by employing this basic fire safety knowledge.

What is Fire Safety?

Fire safety is a set of practises aimed at reducing the amount of damage caused by fire. Fire safety measures include both those that are used to prevent an uncontrolled fire from starting and those that are used to limit the spread and effects of a fire once it has started.
Fire safety measures are those that are planned during the construction of a building or implemented in existing structures, as well as those that are taught to the building's

occupants. Fire hazards are a term used to describe threats to fire safety. A fire hazard can be anything that increases the risk of a fire or makes it difficult to escape in the event of a fire. Building safety frequently includes fire safety. Fire prevention officers are those who inspect buildings for violations of the fire code and go into schools to educate children about fire safety issues.

Typical Fire Risks

The following are some of the most common fire hazards:

- Cooking fires in the kitchen caused by unattended frying, boiling, and simmering.
- Overloaded electrical systems, resulting in hot wiring or connections, or failed components.
- Inadequately protected combustible storage areas
- Combustibles near heat-generating, flame-producing, or spark-producing equipment.
- Candles and other flames
- Tobacco use (cigarettes, cigars, pipes, lighters, etc.).
- Heat-generating equipment that uses combustible materials.
- Liquids and aerosols that are flammable.
- Placing flammable solvent (along with soaked rags) in enclosed trash cans.
- Fireplace chimneys that aren't cleaned properly or on a regular basis.
- Cooking appliances, such as stoves and ovens.
- Fireplaces, wood stoves, furnaces, boilers, and portable heaters are examples of heating appliances.
- Appliances for the home, such as clothes dryers, curling irons, hair dryers, refrigerators, and freezers.
- Creosote-concentrating chimneys.
- Malfunctioning electrical wiring.
- Batteries that are leaking.
- Matches, lighters, and other personal ignition sources
- Electrical and electronic devices.
- Barbecue grills and outdoor cooking equipment.

Prevention of Fire

The goal of fire prevention measures is to reduce the likelihood of a fire starting in a building or premises. Most accidental fires, according to studies, are caused by three main factors:

1. Equipment that isn't working properly
2. Inappropriate use of heat sources
3. Human error

It is possible to reduce the likelihood of a fire starting and thus increase fire safety by paying attention to simple precautions. Because these precautions are properly addressed in other standards and specifications, the Code is not intended to provide complete details. It does, however, call attention to them in broad terms in order to provide a foundation for more positive actions.

It is primarily a question of education and management when it comes to preventing human error. It is in the best interests of property owners and managers to ensure that building occupants are aware of fire hazards and are encouraged to use caution when handling heat sources and equipment in order to avoid a fire.

Enforce good housekeeping practises, which includes establishing routines for the removal and disposal of waste on a regular basis.

1. Establish and maintain after-hours inspection and security procedures, including fire-prevention measures;
2. Perform routine checks, inspections, and tests, such as monitoring the maintenance of heat-generating equipment that could cause fires, chafing of cables, self-heating of cables due to electrical resistance, and fuel supply and storage checks.
3. Issue and monitor work permits, as well as the procedures that go with them;
4. Instruct and supervise contractors and subcontractors working on the building's construction and maintenance.
5. Avoid situations that could result in a gas or dust explosion;
6. Continue to integrate with other systems (e.g. ventilation, communications).

Measures to Prevent Fires

Heaters, cookers, refrigeration units, and other fixed equipment that generates heat or uses energy must be installed in accordance with the provisions of the standards governing their use in buildings. The equipment must be kept in good working order, with no repairs or modifications being performed by unqualified individuals.

All potentially hazardous operations must be carried out in a safe manner by personnel who have been trained to do so.

Operations that require the use of flammable materials must be controlled so that only a small amount of material is present and the rest is kept in a secure location from which it can be withdrawn as needed. Such materials must be kept in a secure location with only authorised personnel having access.

Smoking is prohibited in areas where flammable materials are present, such as stores and factories that use or produce such materials. In such cases, special facilities for employees who need to smoke must be made available. Smoking and the use of naked flames should also be prohibited in places where a fire could pose a special problem for people's escape, such as cinemas, theatres, hospital wards, public transportation, and so on. Notices must be posted to draw attention to the smoking ban, and notices must be illuminated where ambient light conditions are poor.

Cooking appliances that use bottled gas should be properly installed with high-quality connections, and the cylinder should be placed in a secure location away from the appliance if at all possible. Spare gas cylinders must be stored away from the appliance in a secure location.

In organisations with more than 20 employees, management must alert employees to the dangers of a fire and conduct regular drills and training courses to inform them of the safe

procedures to follow. Large organisations should designate specific people to be in charge of safety.

Fixed Fire Fighting Systems

Fixed fire fighting systems (FFS) actively protect a structure, its contents, and its occupants. There have been a few notable incidents where a building's fixed fire fighting system was extremely successful in controlling and extinguishing a fire that the fire department was unable to handle.

Architects may consider including FFS as a compensatory feature during the design stage to provide additional protection to a large space or vulnerable area of a building. FFS are sometimes retrofitted into existing structures to address a historic flaw or reduce the perceived fire risk associated with a change of use or circumstance.

The following are some of the advantages of providing active FFS:

- Increased compartment sizes permitted by Building Regulations
- Lower insurance premiums
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- Lower insurance premiums
- High levels of protection for valuable assets, such as the building fabric or contents
- Improved life safety

The decision to install a fire suppression system such as sprinklers will be based on a number of factors that should all be identified during the risk assessment process.
Such factors will include:

- The likelihood of the event
- The consequences or outcome of the event
- The location of the building/s
- How accessible the buildings are
- Vulnerability to intruders through the perimeter of the site
- Whether there is public access to the site
- How good the security system is
- The vulnerability of the construction materials to catch fire (sprinklers or other water-based systems).

Any FFS must be able to detect, activate, and suppress a fire in order to function effectively. The following are the most common FFS:

- Water mist systems
- Automatic water sprinklers
- Drencher systems
- Flooding and inerting systems

These systems are discussed below.

Automatic Water Sprinkler Systems

Automatic water sprinkler systems provide effective fire suppression in the majority of a building's areas, ensuring:

- Fire detection at an early stage
- The provision of a local alarm system operation, as well as confirmation of the alarm at the central control room, and
- The transmission of an alarm to the fire service, if appropriately arranged.

The basic elements of any sprinkler system are depicted in the diagram below.

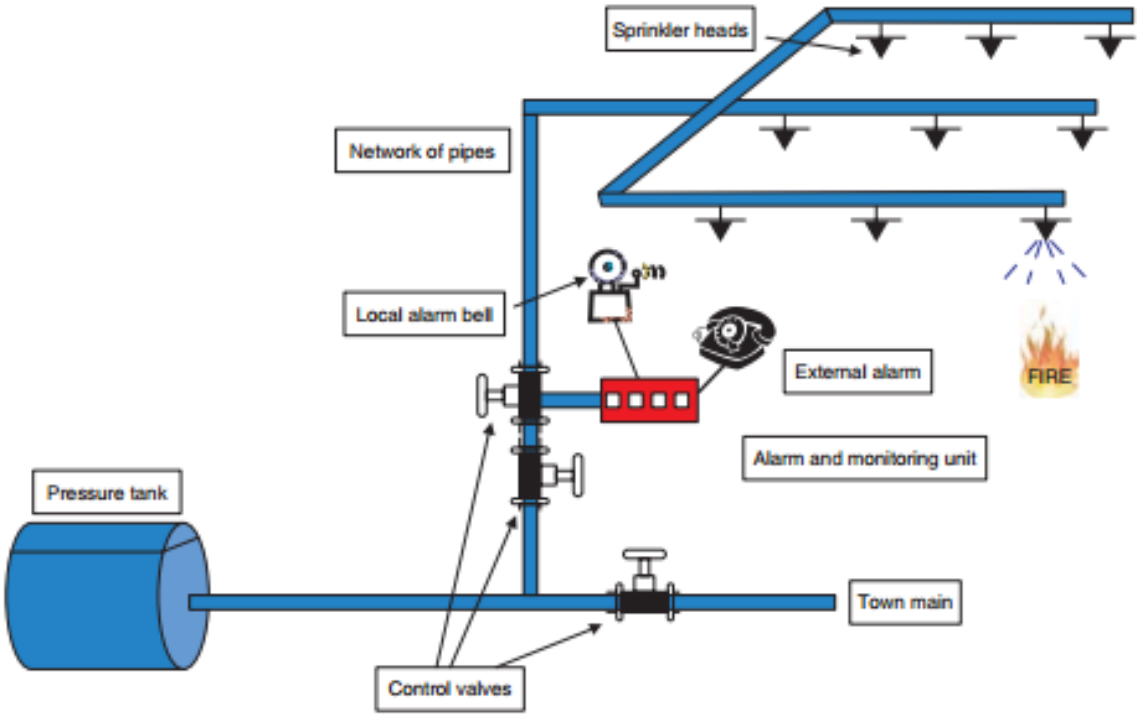

Figure 1.2: *A basic sprinkler system's typical layout, showing the key components*

Automatic Water Sprinkler System Types

- Wet, Dry, and Alternate Sprinkler Systems
  Pre-Action Sprinkler Systems
- Domestic Sprinklers
- Drenchers
- Flooding and Inerting Systems

Portable Fire Fighting Equipment

Extinguishers are typically designed to combat one or more types of fire. Red is the colour of all extinguishers that meet current regulations. They use a color-coded panel that should cover at least 5% of the extinguisher's body to distinguish the different types of extinguishers.

The size of the fire extinguisher provided for each location is determined by the fire risk and the number of people who may need to use it. Extinguishing equipment is divided into seven categories:

- Aqueous film forming foam (AFFF)
- Water
- Foam
- Dry powder
- Wet chemical
- Carbon dioxide
- Fire blanket

Water – water extinguishers are most commonly found in offices and other places of business where the combustible material is carbonaceous, such as wood, paper, plastic, and other similar materials. Cooling the fire extinguishes it.

Figure 1.3: Pressure gauge on the neck of a water extinguisher

AFFF – Aqueous film-forming foam (AFFF) extinguishers are nearly identical to water type extinguishers except that they have a foam additive in the water (aqueous film-forming foam) that increases the extinguisher's efficiency and thus creates a faster knockdown with fewer media. The AFFF cools the fire and extinguishes it.

Foam – foam extinguishers are built similarly to water extinguishers, with the foam being expelled from the cylinder's body by stored pressure. The foam is made by aerating premixed foam through a special attachment at the discharge hose's end. Foam floats on the burning surfaces of oils and other flammable liquids because it is less dense than water. It puts out the fire by suffocating it, or preventing air from reaching the fuel.

Dry powder – The stored pressure in a CO2 cylinder expels the dry powder from the extinguisher. When the CO2 is turned on, the dry powder becomes liquid and is discharged

through the hose to the nozzle. Smothering, or forming a barrier between the burning fuel and the air, is how dry powder puts out a fire. It is the only extinguishing medium capable of putting out flowing fuel fires.

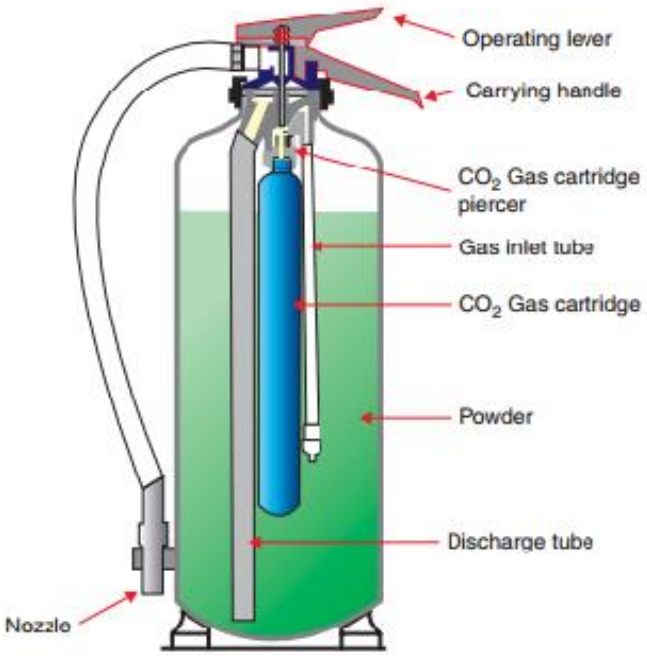

Figure 1.4: Dry Powder Extinguisher

Carbon dioxide (CO2) – CO2 extinguishers only contain CO2 that has been pressurised to the point where it is a liquid. The liquid CO2 is discharged through the discharge tube when the operating lever is depressed. A horn is installed at the tube's end to slow the rush of pressurised CO2 and direct it toward the fire. These extinguishers work by smothering the fire by replacing the immediate atmosphere of air with an inert gas that does not support combustion.

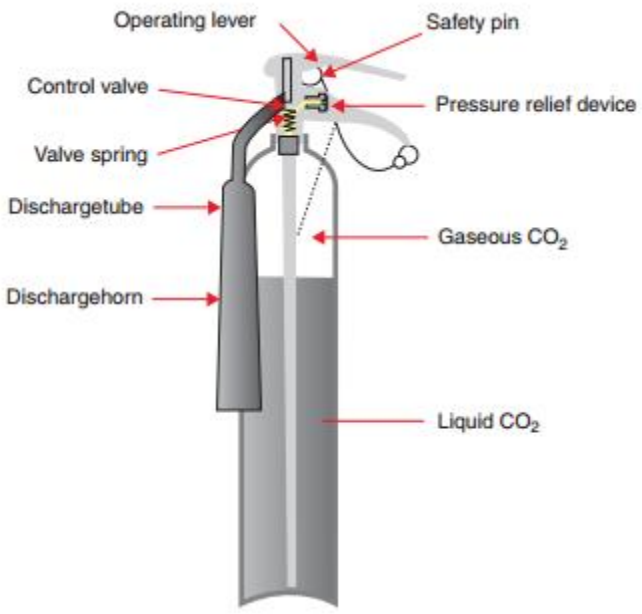

Figure 1.5 : Carbon dioxide extinguisher

Figure 1.6: Wet chemical fire extinguisher

CO2 is the only medium that can be used to safely fight electrical equipment fires; however, it has a number of drawbacks:

- They only operate for a short period of time; the smaller ones may only last 12 seconds
- They do not cool the fire and thus the fire can easily reignite unless the CO2 is periodically reapplied

- They do not work in an open area where draughts may cause the CO2 to disperse

Wet Chemical Fire Extinguishers – These fire extinguishers were created specifically for use on fires involving cooking oils and fats. For this type of fire risk, they are the most effective type of extinguisher. Extinguishers work by spraying a wet chemical agent onto the surface of the burning oil or fat through a spray nozzle. The wet chemical agent reacts with the burning oil or fat to form a 'suds-like' blanket across the surface of the fuel. This 'suds-like' blanket extinguishes the fire by preventing the release of flammable vapours and excluding the air.

Siting of Portable Extinguishing Equipment

Extinguishers and fire blankets, in general, should be placed in areas where they are visible and easily accessible for immediate use.
For general protection, extinguishers should be:

- Near stairwells
- Along corridors or landings
- Near exits

Extinguishers should not be kept in the following locations:

- Behind doors, in cupboards, or deep recesses
- In places where they might obstruct exit routes or be damaged by trolleys or vehicles
- Over or near heating appliances
- Where they might be subjected to extremes of heat or cold
- Where they are exposed to wet or damp atmospheres

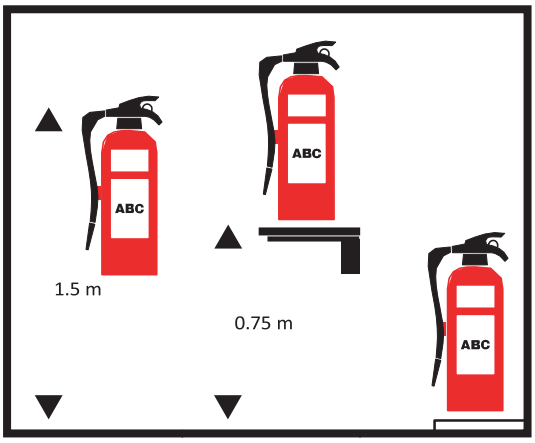

Figure 1.7: Mountings for portable fire extinguishers

Managing Portable Extinguishing Equipment

Portable fire fighting equipment, like all other fire protection systems, must be constantly monitored. Extinguishers must be provided, installed, inspected, and tested in accordance with manufacturer recommendations, which must include an annual test and inspection by a competent person. Extinguishers should also be inspected on a regular basis to ensure that

they are in working order, are full and in good condition, and have been tested by a competent person within the required time frame.

Fire Alarm and Detection Systems

Installing an automatic system that detects and raises the alarm will significantly improve both life and building safety, as well as provide the following advantages:

- Early detection of fires in unoccupied areas of the building, such as storerooms and boiler rooms;
- Early notification of occupants of a fire to allow for effective escape
- Operation of other protective devices, such as:
- Automatic door closers or stairway pressurisation systems
- Shutting down ventilating and air conditioning plant
- Activating fire control systems
- Opening ventilators or starting fans for smoke control
- Opening doors or ventilators
- Operating door release mechanisms, etc.

Automatic fire detection and alarm systems are available in a variety of configurations, including:

- Aspirating Smoke Detectors
- Smoke Detectors
- Heat Detectors
- Beam Smoke Detectors
- Linear Heat Detecting Cable (LHDC)
- Flame Detectors

Figure 1.8: An ionisation smoke detector

Figure 1.9: A typical heat detector

Figure 1.10: Beam detector

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Figure 1.11: Flame detector

Further Reading:

- ✓ An Introduction to Fire Dynamics 3rd Edition, Kindle Edition by Dougal Drysdale ,2011
- ✓ Introduction to Fire Protection 4th Edition by Robert W. Klinoff 2011