POLITEKNIK MUKAH

FIRE SAFETY

FIRST EDITION

MUHAMMAD KAMIL JAZLI BIN ABD WAHAB
MOHAMAD IQMAL HANAFI BIN AHMAD HISHAM
NIK AZNAN BIN AB HADI

FIRE SAFETY

FIRST EDITION

POLITEKNIK MUKAH SARAWAK

MUHAMMAD KAMIL JAZLI BIN ABD WAHAB
MOHAMAD IQMAL HANAFI BIN AHMAD HISHAM
NIK AZNAN BIN AB HADI

FIRE SAFETY

FIRST EDITION

Published by:
Politeknik Mukah
KM7.5 Jalan Oya,
96400 Mukah,
Sarawak.
Tel: 084-874001
Fax: 084-874005

Website: http://www.pmu.edu.my

Authors:
Muhammad Kamil Jazli bin Abd Wahab
Mohamad Iqmal Hanafi bin Ahmad Hisham
Nik Aznan bin Ab Hadi

Data Pengkatalogan-dalam-Penerbitan

Perpustakaan Negara Malaysia

Rekod katalog untuk buku ini boleh didapati dari Perpustakaan Negara Malaysia

eISBN 978-967-2097-72-3

PREFACE

Fire safety is an essential consideration for everyone whether you are a homeowner, business owner or a member of the public. Fires occur unexpectedly, without warning, and the consequences can be disastrous. It is crucial to have solid understanding of fire safety measures to prevent fires from starting and to have the knowledge to react appropriately in case of a fire.

This e-book on fire safety aims to provide practical information and guidance on how to prevent fires and respond effectively. The book is written in an easy-to-understand manner and everyone who wants to learn more about fire safety will be benefited from this.

The content is based on industry best practices and guidelines as outlined in international standards such as MS 1722:2011, MS 1539:2013 and MS 1974:2014.It covers a wide range of topics including basic of fire, fire safety planning and evacuation plan.

We hope this e-book will help you gain a better understanding of fire safety and equip you with the knowledge and skills to stay safe in the event of a fire. Stay safe!

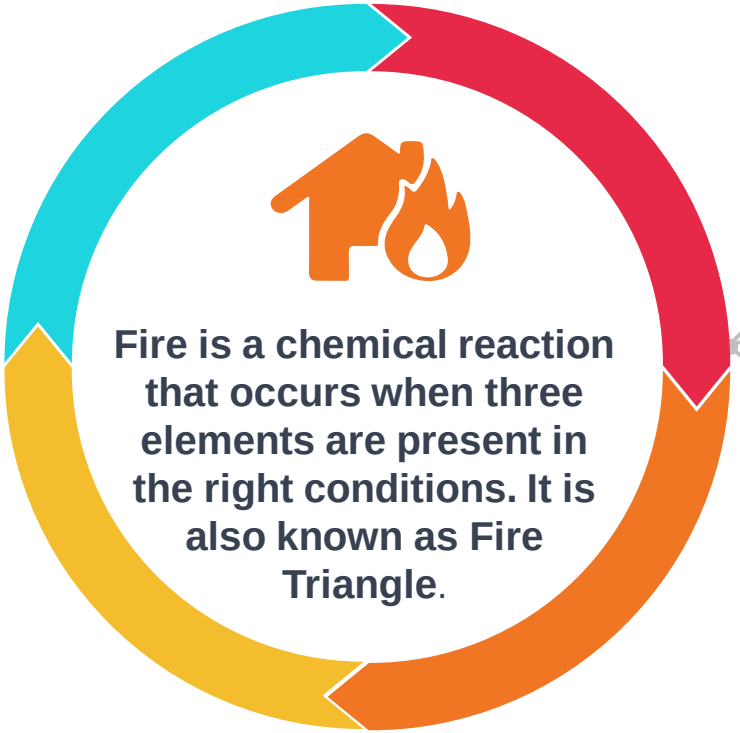
TABLE OF CONTENT

01

BASIC OF FIRE

FIRE SAFETY | FIRST EDITION

BASIC OF FIRE

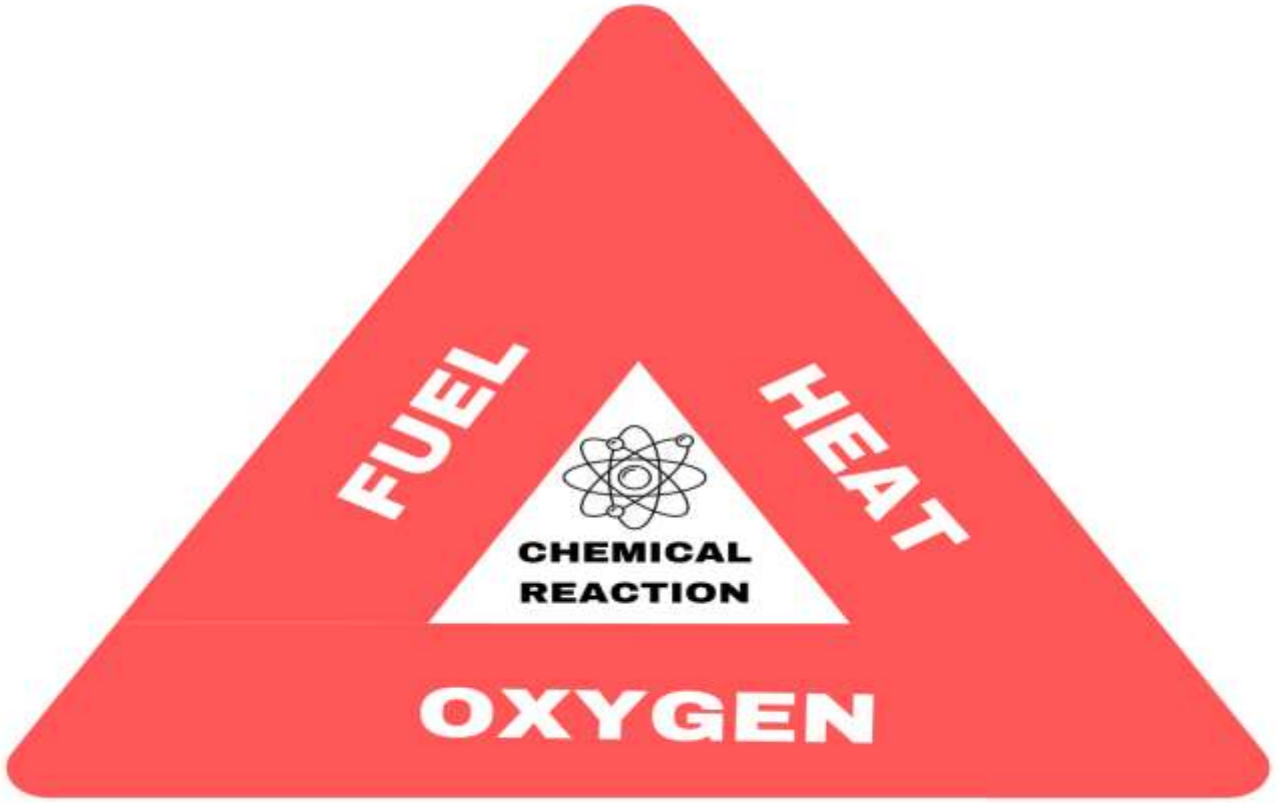


FUEL

OXYGEN

HEAT

FIRE TRIANGLE



FUEL

Fuel can be any **SOLID**, **LIQUID**, or **GAS** that contains carbon and hydrogen atoms, which can be oxidized during the combustion process.

The type and amount of fuel present at a fire can significantly affect the behavior and severity of the fire. Large quantities of fuel can cause the fire to spread rapidly and generate significant heat, while certain types of fuels can produce toxic fumes when burned.

SOLID

Coal, Wood, Paper, Cloth, Wax, Grease & Plastic.

LIQUID

Gasoline, Kerosene, Paint, Alcohol & Varnish.

GAS

Natural gas, Propane, Butene, Hydrogen

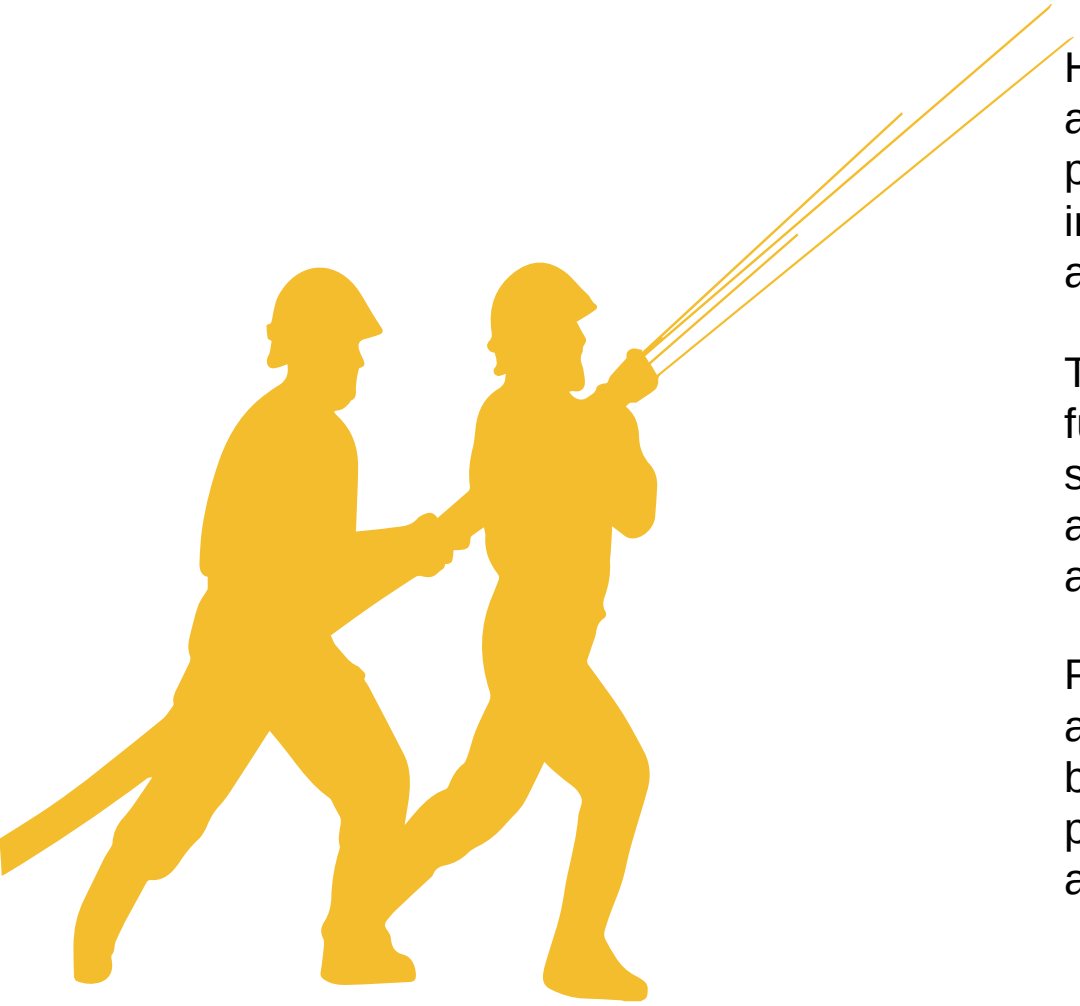
Individuals can reduce the risk of fires by being aware of potential fire hazards related to fuels and taking appropriate precautions, such as safely storing and handling flammable materials.

OXYGEN

Oxygen is a gas that is required for combustion to occur. Oxygen is one of the three essential elements of the fire triangle, along with fuel and heat.

Air contains about 21% oxygen, and most fires require at least **16% OXYGEN** content to burn. Oxygen supports the chemical processes that occur during fire.

HEAT



Heat refers to the energy required to raise the temperature of a fuel to its ignition point, which is the minimum temperature at which the fuel will spontaneously ignite and burn.

Heat is one of the three essential elements of the fire triangle, along with fuel and oxygen. When fuel and oxygen are present in sufficient quantities, the application of heat can initiate a chemical reaction that releases energy in the form of a flame.

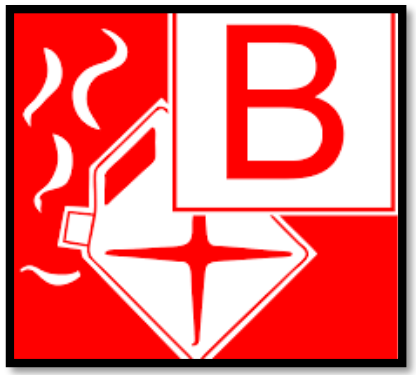
The heat generated by the initial flame can then cause nearby fuel to release gases that sustain the fire, creating a self-sustaining chain reaction. The intensity of the fire and the rate at which it spreads depend on the amount of heat generated and the availability of fuel and oxygen.

Preventing fires from occurring in the first place is also crucial, and individuals can reduce the risk of fires related to heat by being aware of potential fire hazards and taking appropriate precautions, such as properly maintaining heating equipment and avoiding leaving heat sources unattended.

CLASS OF FIRE

MS 1539:2013 standard

CLASS A



CLASS B

CLASS C

CLASS D

CLASS E

CLASS F

CLASS A

Involves ordinary combustibles, such as wood, paper, cloth, trash or plastics.

This type of fire usually occurs in homes, offices, schools and other structures where these materials are commonly found.

CLASS B

Involves flammable liquids or gases, such as gasoline, oil, propane, or solvents. This type of fire can be particularly dangerous because these fuels can ignite easily and spread quickly.

Class B fires typically produce flames and they can be extinguished by interrupting the chemical reaction between the fuel and oxygen or by removing the fuel source.

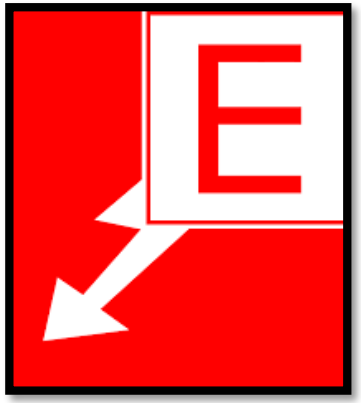
CLASS C

Involves energized electrical equipment, such as electrical panels, wiring, motors, and appliances. These fires can be particularly dangerous because of the potential for electrocution and the risk of the fire spreading through the electrical system.

CLASS D

Involves combustible metals. This includes metals such as magnesium, titanium, lithium, sodium, and potassium, which can ignite and burn at high temperatures.

It is important to note that Class D fires are relatively rare and typically only occur in industrial or laboratory settings where these metals are used or stored.



CLASS E

Involves electrical equipment that are caused by an explosion. This can include fires caused by the explosion of batteries or capacitors in electronic devices.

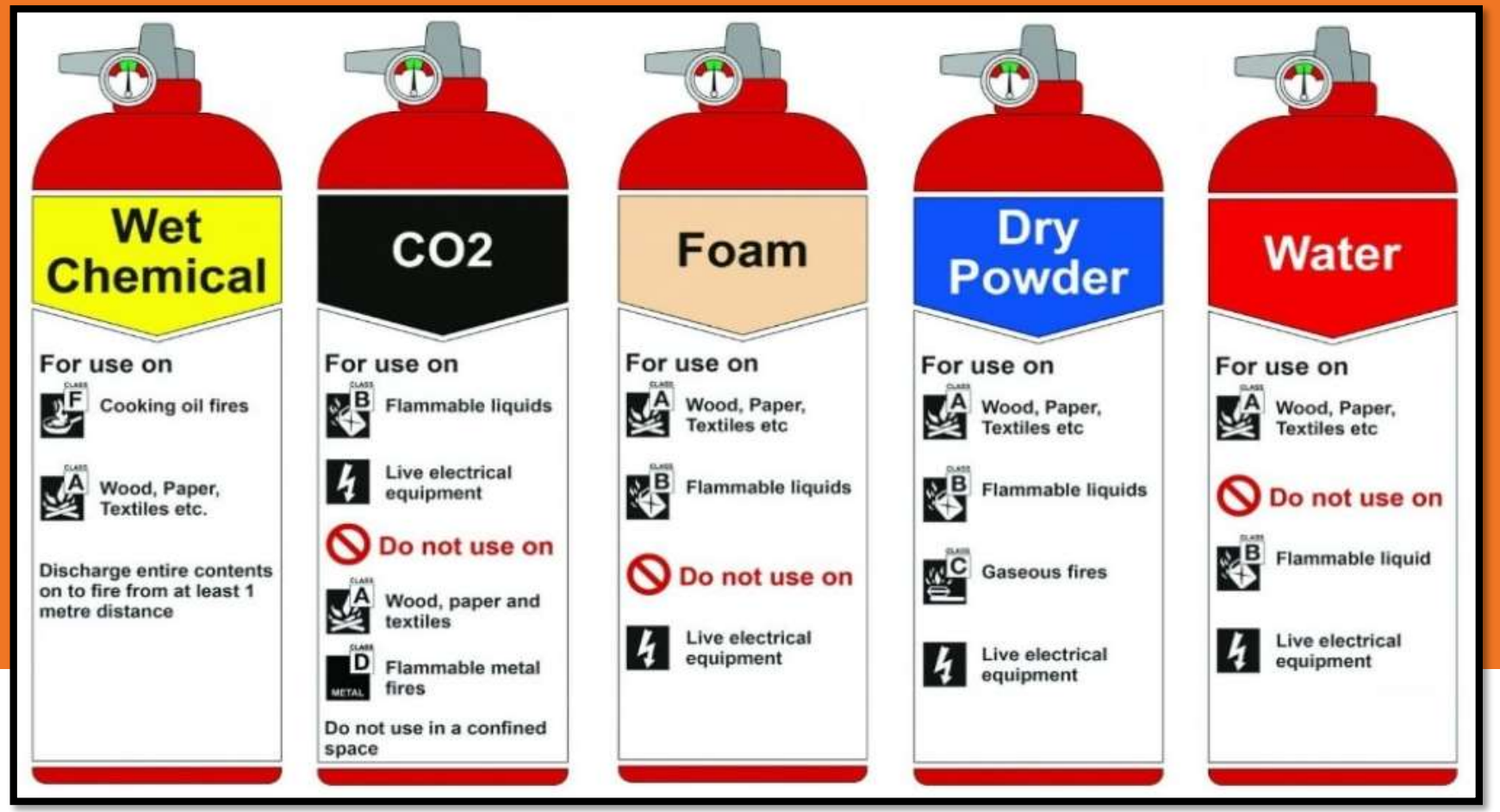
Class E fires are similar to Class C fires in that they involve energized electrical equipment but they are distinguished by the fact that they are caused by an explosion rather than a fault in the electrical system.

CLASS F

Involves cooking oils or fats, such as in commercial kitchens or restaurants. These fires can quickly become out of control and difficult to extinguish due to the high temperatures of the burning oils.

Class F fires are distinct from Class A fires which involve ordinary combustibles such as wood, paper or cloth and Class B fires which involve flammable liquids or gases.

TYPE OF FIRE EXTINGUISHER AND USES



02

FIRE SAFETY PLANNING

FIRE SAFETY PLAN

MS 1722:2011

The Malaysian standard used for fire safety plans is MS 1722:2011 - Code of practice for fire safety in buildings.

It provides guidelines for the development of fire safety plans for buildings in Malaysia including identification of fire hazards, establishment of emergency procedures, selection and installation of fire protection systems together with training of personnel on fire safety.

MS 1722:2011 is recognized by Malaysian government and is widely used by building owners, architects, engineers and fire safety professionals to ensure the buildings are designed and operated in a safe manner with regards to fire protection.

STEP 1

CONDUCT A FIRE RISK ASSESSMENT

The process involves identifying potential fire hazards, assessing the risk of fire and identifying measures to mitigate or eliminating the risk of fire. This will form the basis of the fire safety plan.

By conducting fire risk assessment, building owners and fire safety professionals will identify potential fire hazards, assess the risk of fire and develop effective control measures to prevent or mitigate the risk of fire. This helps to protect people and property from the devastating effects of fire.

STEP 2

DEVELOP FIRE EMERGENCY PROCEDURES

Develop detailed emergency procedures that outline the steps to be taken in the event of a fire including alarm system, evacuation procedures and designated assembly points. This should include procedures for different types of occupants, including visitors and people with disabilities.

Fire emergency procedures are designed to ensure that everyone in the building or site knows what to do in the event of a fire and evacuate the building safely and quickly.

STEP 3

ESTABLISH FIRE PREVENTION MEASURES

Fire prevention measures are designed to reduce the risk of fire occurring in the first place and to minimize the potential for fire to spread.

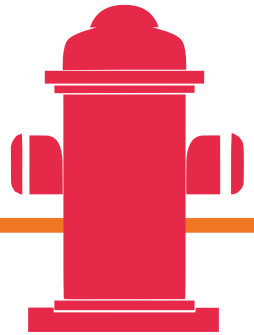
By establishing fire prevention measures, building owners and fire safety professionals can reduce the likelihood of a fire occurring and the possibility for damage and loss of life.

STEP 4

INSTALL FIRE PROTECTION SYSTEMS

Fire protection systems are intended to detect, suppress and notify building occupants of the need to evacuate safely. The fire protection systems include fire alarms, fire suppression systems, fire extinguishers and smoke control systems.

By installing fire protection systems, building owners and fire safety professionals can reduce the risk of a fire occurring, limit the spread of fire and provide early warning to building occupants to evacuate safely.



STEP 5

ESTABLISH FIRE SAFETY MANAGEMENT PROCEDURES

Establish procedures for the ongoing management of fire safety, including regular inspections and maintenance of fire protection systems, testing of emergency procedures and training of personnel.

Fire safety management procedures help to ensure building occupants are aware of fire risks and prepare to respond to fire emergency.

STEP 6

DEVELOP EVACUATION PLANS

An evacuation plan is a detailed plan with outlines of procedures to be followed in the event of a fire emergency. It provides clear guidance to the building occupants on how to evacuate the building quickly and safely.

Develop evacuation plans that take into account the characteristics of the building is the number and location of occupants and the accessibility of emergency exits.

STEP 7

TRAIN PERSONNEL

Train Personnel is one of the steps that must be included in the fire safety plan. This procedure involves developing and implementing a comprehensive training program to educate employees, occupants and other relevant parties on the fire safety procedures, emergency evacuation routes and the proper use of fire protection equipment.

Regular fire drill training helps to ensure everyone in the building is prepared for ~~a~~ fire emergency while familiarizing them with appropriate actions to minimize damage and prevent injuries or fatalities.

STEP 8

REVIEW AND UPDATE THE PLAN

Review and update the plan is one of the steps that must be included in the fire safety plan. This involves conducting regular reviews and updates of the fire safety plan to ensure it remains up-to-date and relevant to the shifting conditions and operations of the building.

FIRE CONTROL METHOD

The fire control method involves extinguishing and controlling a fire that already occurred or is in progress. It involves using firefighting equipment and techniques to suppress the fire, prevent its spread, and eventually extinguish it. The goal is to minimize damage to property and protect human life. There are generally four methods used in fire control, which are:

FIRE CONFINEMENT

COOLING

SMOTHERING

STARVATION

COOLING

Cooling is one of the methods used in fire control. It involves reducing the temperature of the fuel or the fire source below its ignition point. By doing so, it will extinguish the fire or prevent it from spreading.

This is done by applying water, foam or other cooling agents to the burning material or the fire source. Cooling can also be accomplished by using fire sprinklers or fire hoses to apply water or other agents onto the flames or the surrounding area to reduce the temperature.

Cooling is particularly effective in Class A fires involving solid materials such as wood, paper, and textiles.

SMOTHERING

Smothering is a fire control method that involves depriving a fire of oxygen, which is one of the essential elements required for combustion to occur.

This method involves using materials that can form a blanket over the fire and prevent the flames from reaching oxygen.

The lack of oxygen causes the fire to extinguish or cool down, preventing it from spreading or causing further damage.

FIRE CONFINEMENT

Involves preventing the spread of fire to other areas or materials by enclosing it within a specific space or location. This method aims to limit the size of the fire and prevent it from spreading to adjacent areas, which can help minimize damage and protect people and property.

Fire confinement is a useful technique in situations where the fire cannot be extinguished immediately such as in large fires or when the fire is caused by flammable liquids. By confining the fire to a smaller area, firefighters can gain more control over the situation and focus their efforts on extinguishing the fire in a controlled manner.

STARVATION

Involves removing one or more elements of the fire triangle, specifically fuel or oxygen, to extinguish a fire. By removing the fuel source or reducing the oxygen concentration, the fire is deprived of the necessary elements to continue burning and it will eventually die out.

This method is often used in situations where other methods are not effective or where using water or other extinguishing agents is not safe or feasible. Some common examples of starvation as a fire control method include turning off a gas valve to remove the fuel source or using a fire blanket to smother a fire and cut off the oxygen supply.

FIRE PROTECTION METHOD

PASSIVE FIRE PROTECTION

This involves the use of building materials and design techniques that are inherently resistant to fire, such as fire-resistant walls, doors, and ceilings. Passive fire protection is intended to prevent the spread of fire and smoke and to protect occupants of a building from fire hazards.

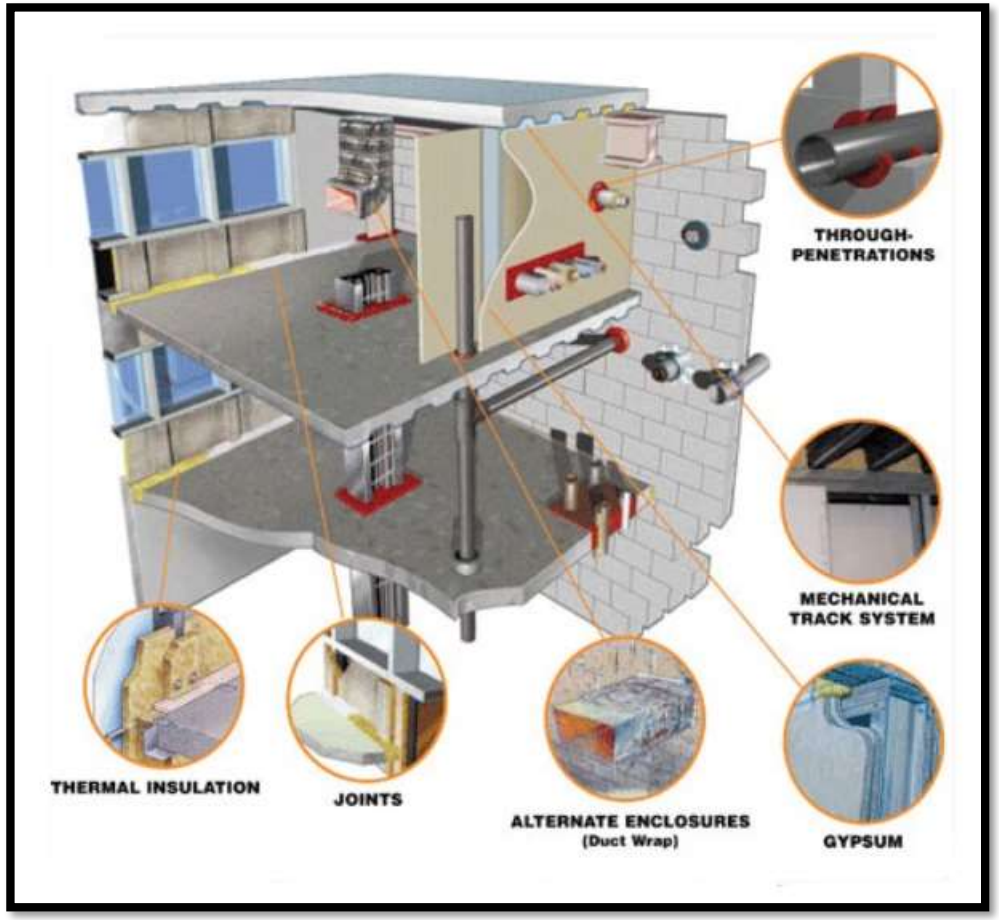
ACTIVE FIRE PROTECTION

This involves the use of fire detection and suppression systems, such as smoke detectors, fire alarms, sprinklers, and fire extinguishers. Active fire protection systems are designed to detect and control fires in their early stages to prevent them from growing and causing extensive damage.

PASSIVE FIRE PROTECTION

Passive fire protection refers to fire safety measures that are designed to contain or **slow down the spread of fire** and smoke by creating fire-resistant barriers between different areas of a building or structure. It is a critical component of a building's overall fire protection strategy, working alongside active fire protection systems such as fire alarms and fire extinguishers.

Passive fire protection methods include structural fire protection measures such as **fire-resistant walls**, **floors** and **doors** as well as **fire-rated glass** and **dampers**. Other examples include firestops to seal openings around pipes and cables, fire barriers to prevent fire spread, and fire-resistant coatings for building materials.



FIRE RESISTANT WALL & FLOOR

FIRE RESISTANT DOOR

ACTIVE FIRE PROTECTION

Fire detection and alarm systems

These systems use sensors to detect smoke or heat and activate an alarm to alert building occupants of a potential fire. They may also alert the fire department or activate sprinklers or other suppression systems.

Automatic sprinkler systems

These systems use heat-activated sprinkler heads to discharge water and extinguish or control fires in a building. They can be either wet or dry systems, depending on the environment and the potential for freezing pipes.

Fire suppression systems

These systems use chemical agents, such as foam or dry chemical powder, to suppress or extinguish fires. They are often used in areas where water cannot be used as a suppression agent, such as electrical rooms or data centers.

Fire pumps and standpipes

These systems provide water to sprinklers, hose reels, and other firefighting equipment in the event of a fire. They are often installed in high-rise buildings to ensure that firefighters have access to water at all levels.

Portable fire extinguishers

These are handheld devices that can be used to extinguish small fires or to provide initial suppression until the fire department arrives. They are typically filled with dry chemical powder, foam, or carbon dioxide.

SMOKE DETECTOR

FIRE DETECTION & ALARM SYSTEM

Conventional fire alarm systems

In this type of system, the building is divided into zones, and each zone is connected to a control panel. When a detector in a zone detects smoke or heat, it sends a signal to the control panel, which activates an alarm in that zone.

Addressable fire alarm systems

These systems allow each detector in the building to have a unique address, which enables the control panel to pinpoint the exact location of the fire. This system is more advanced than a conventional system and is useful in larger buildings.

Aspirating smoke detection systems

This type of system detects smoke particles in the air using a network of pipes and a sampling chamber. It is more sensitive than other systems and is often used in areas where smoke detection is critical, such as data centers or museums.

Flame detection systems

These systems are designed to detect the presence of flames using sensors that detect the infrared radiation produced by a fire.

AUTOMATIC SPRINKLER SYSTEM

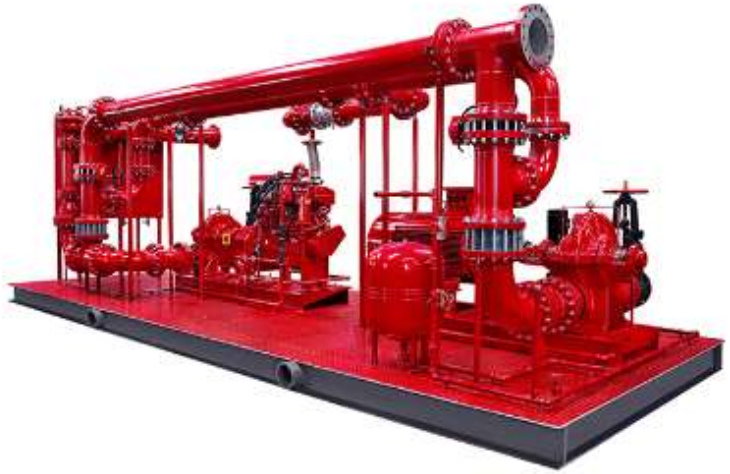
An automatic sprinkler system is a type of fire protection system that utilizes water as the extinguishing agent. The system consists of a network of pipes that are filled with water and strategically placed sprinkler heads that automatically release water when a fire is detected.

The effectiveness of an automatic sprinkler system depends on the type of sprinkler heads used, the spacing of the sprinkler heads, and the water supply available.

FIRE SUPPRESSION SYSTEM

Fire suppression systems are designed to extinguish fires quickly and effectively in order to prevent or minimize damage to property and protect lives.

These systems can use a variety of suppression agents including water, foam, dry chemical, carbon dioxide and others, depending on the type of fire and the nature of the hazard being protected.



FIRE PUMP

Designed to increase the water pressure and flow rate in a building's water supply, ensuring that firefighters have access to the necessary amount of water at the right pressure to extinguish a fire. They are typically powered by electricity, diesel engines or steam turbines and can be located in a separate pump room or in a basement.

STAND PIPE

Standpipes are vertical pipes that are installed throughout a building and connected to a water supply with outlets on each floor equipped with fire hoses and nozzles for firefighters to use. Standpipes allow firefighters to easily access water on any level of a building even in high-rise structures where the water pressure may not be sufficient without the use of a pump.

PORTABLE FIRE EXTINGUISHER

Portable fire extinguishers are hand-held devices used to extinguish small fires. They are an important part of fire protection systems in many buildings and are used to contain fires before they spread and become uncontrollable. The primary function of a fire extinguisher is to remove one of the elements of the fire triangle. Proper selection, installation and maintenance of portable fire extinguishers are critical for their effectiveness.

FIRE EXTINGUISHER

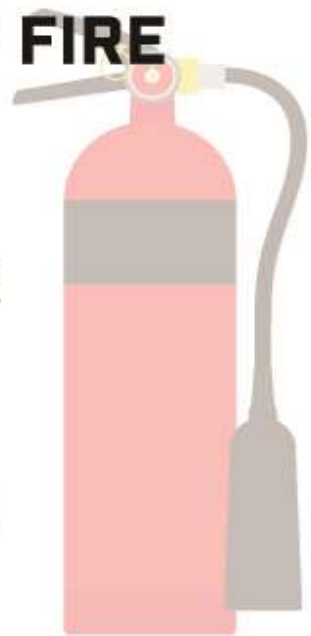
HOW TO USE A FIRE EXTINGUISHER

PULL THE PIN

AIM AT THE BASE OF FIRE

SQUEEZE THE LEVER

SWEEP SIDE TO SIDE



Fun Facts

A firefighter needs 100 hours of training before legally being allowed to enter the interior of a burning building.

03

ESCAPE ROUTE

FIRE SAFETY | FIRST EDITION

EMERGENCY EVACUATION PLAN

R REMAIN CALM AND FOLLOW ALL INSTRUCTIONS

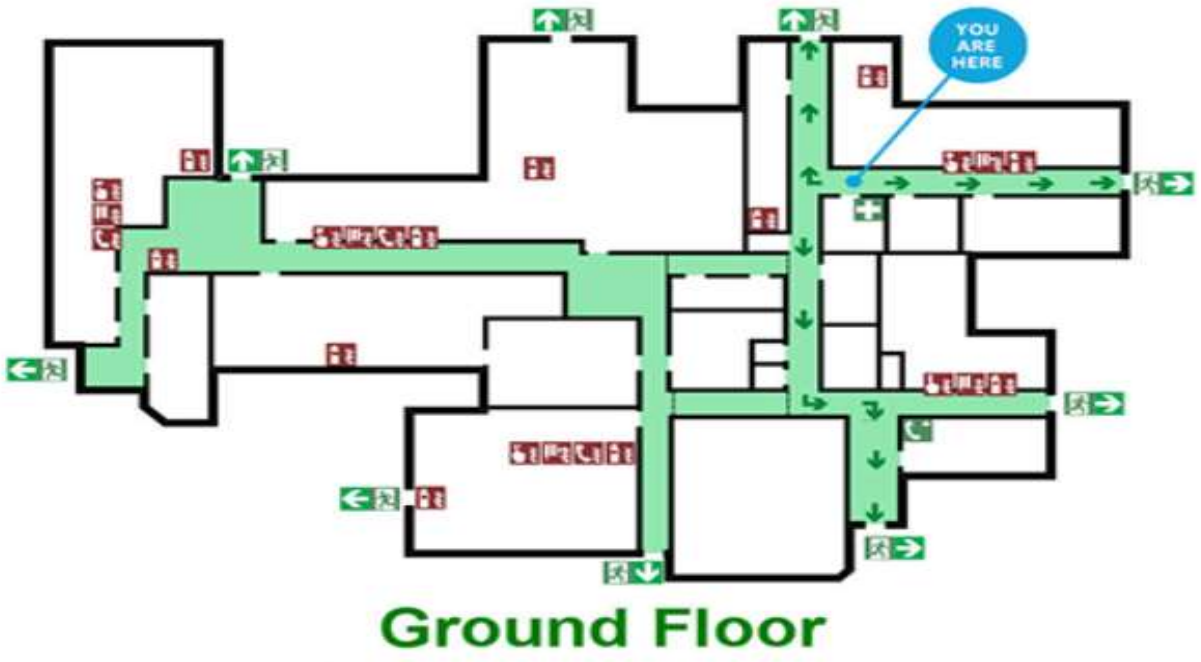
E EXIT BUILDING QUICKLY THROUGH DESIGNATED ESCAPE ROUTE

A ALERT OTHERS

C CLOSE DOOR AND WINDOWS TO CONTAIN FIRE BUT ONLY IF POSSIBLE

T TAKE THE STAIRS NOT THE LIFT

EMERGENCY EVACUATION PLAN



ASSEMBLY POINT

Assembly point should be located in a safe area with reasonable distance from the building or area being evacuated, and should be clearly marked and communicated to all occupants in advance.

The assembly point should also have sufficient space to accommodate all occupants and allow for emergency services personnel to access the building or area if necessary.

The emergency evacuation plan should clearly indicate the designated assembly point and provide instructions on how to get there from different locations within the building or area.

REFERENCES

Standards Malaysia. (2011). *MS 1722:2011 Fire Safety Guidelines.* Putrajaya, Malaysia: Standards Malaysia.

Department of Standards Malaysia. (2013). *Code of practice for fire safety in buildings and structures (MS 1539:2013).* Department of Standards Malaysia.

Department of Standards Malaysia. (2014). *MS 1974:2014. Code of practice for fire safety in buildings.*

Kodur, V., Kumar, P., & Rafi, M. M. (2020). *Fire hazard in buildings: review, assessment and strategies for improving fire safety.* PSU research review, 4(1), 1-23.

Buchanan, A. H., & Abu, A. K. (2017). *Structural design for fire safety.* John Wiley & Sons.

Abidin, E. Z., & Irniza, R. (2015). *Occupational safety and health management system in Malaysia: Comparison between OHSAS 18001: 2007 and MS 1722: 2011.* International Journal of Public Health and Clinical Sciences, 2(3), 23-32.

AUTHORS

KAMIL JAZLI
Lecturer
Electrical Engineering Department
Politeknik Mukah Sarawak

IQMAL HANAFI
Lecturer
Electrical Engineering Department
Politeknik Mukah Sarawak

NIK AZNAN
Lecturer
Electrical Engineering Department
Politeknik Mukah Sarawak

AUTHORS :

MUHAMMAD KAMIL JAZLI BIN ABD WAHAB

MOHAMAD IQMAL HANAFI BIN AHMAD HISHAM

NIK AZNAN BIN AB HADI

e ISBN 978-967-2097-72-3

9 789672 097723