DESIGN OF FIRE PROTECTION SYSTEM (BASIC)

INTRODUCTION

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SEKSYEN TEKNIKAL,
BAHAGIAN PENGURUSAN ASET,
ARAS 12, PRESINT 5, MENARA 2,
KEMENTERIAN PENDIDIKAN MALAYSIA
WILAYAH PERSEKUTUAN PUTRAJAYA

TARIKH : 03-05 FEBRUARI 2020
TEMPAT : CREATE, ALOR GAJAH, MELAKA

OBJEKTIF

- PENGENALAN SISTEM PENCEGAH KEBAKARAN
- MENGENALI SISTEM PENCEGAH KEBAKARAN (JENIS AKTIF) YANG DIGUNAKAN OLEH INDUSTRI
- MEMBERI KEFAHAMAN TERHADAP AKTA, GARIS PANDUAN, STANDARD, CODE OF PRACTICE YANG BERKAITAN YANG DIGUNAPAKAI OLEH PEREKABENTUK
- MEMBERI KEFAHAMAN KONSEP REKABENTUK BAGI SISTEM-SISTEM ASAS PENCEGAH KEBAKARAN
- MEMBERI KEFAHAMAN KAEDAH MEMBERI INPUT REKABENTUK MEKANIKAL KEPADA LAIN-LAIN DISIPLIN
- AMALI REKABENTUK SISTEM ASAS PENCEGAH KEBAKARAN

OUTCOME KURSUS

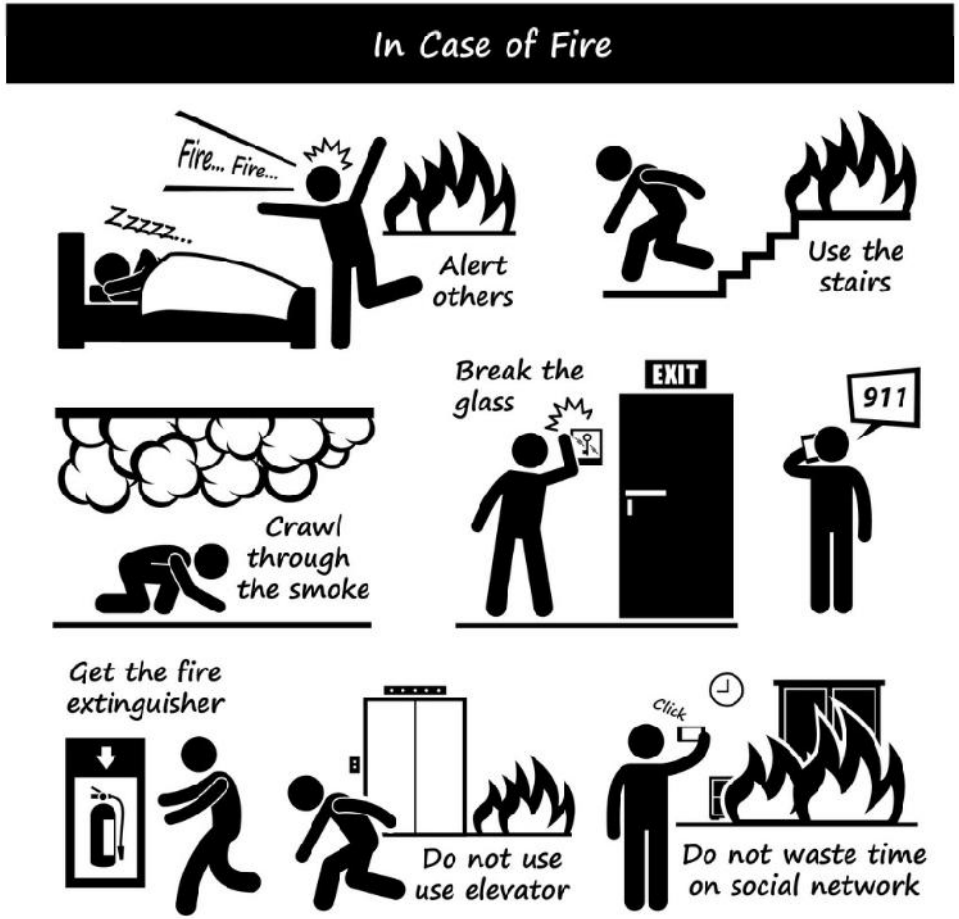
- MENGETAHUI KEPERLUAN PIAWAIAN DAN PIHAK BERKUASA
- MENGETAHUI KONSEP DAN PRINSIP REKABENTUK SISTEM ASAS PENCEGAH KEBAKARAN
- BOLEH MEREKABENTUK SISTEM ASAS PENCEGAH KEBAKARAN
- BOLEH MEMBUAT PENGIRAAN BAGI PERALATAN SISTEM ASAS PENCEGAH KEBAKARAN
- BOLEH MENGENALPASTI INPUT TEKNIKAL YANG DIPERLUKAN DALAM REKABENTUK SISTEM ASAS PENCEGAH KEBAKARAN

SISTEM PENCEGAH KEBAKARAN (ASAS)

APAKAH TUJUAN SISTEM PECEGAH KEBAKARAN DALAM BANGUNAN?

SISTEM PENCEGAH KEBAKARAN (ASAS)

APAKAH TUJUAN SISTEM PECEGAH KEBAKARAN DALAM BANGUNAN?



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TUJUAN SISTEM PENCEGAH KEBAKARAN

PROTECTION OF HUMAN LIVES

THE PROTECTION AIMS ARE

ENVIRONMENTAL PROTECTION

PRESERVATION OF MATERIAL ASSETS

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TUJUAN SISTEM PENCEGAH KEBAKARAN

SAFETY FOR LIFE

Life safety is the ultimate consideration in building design

Our Main Goal

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'LIFE SAFETY' ASPECT IN FIRE PROTECTION

Life safety of OCCUPANTS of buildings must always be priority and this can be achieved by minimum fire protection in respect of the various basic aspects of:

- **Means of escape for occupant/evacuation**

- **Spread of fire within the building (from one building to another/ passive containment)**

- **Means of detection and extinguishing of fire (active intervention & access for fire fighting and rescue)**

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WHAT IS 'FIRE'?

- FIRE is the result of Chemical Reaction.
- FIRE is the visible effect of the process of combustion.
- When the oxygen in the air combines with carbon and hydrogen in a fuel, a chemical reaction take place.
- The reaction will keep going as long as there is enough Heat, fuel and oxygen.
- Energy in the form of heat and light is released in the process.
- This what we call FIRE.

SISTEM PENCEGAH KEBAKARAN (ASAS)

WHAT IS 'FIRE'?

- Fire is a kind of oxidation as combustion. In combustion, oxidation take place rapidly producing a mixture of gases and energy.
- Although energy is released as heat and light, but some gases become visible as smoke.

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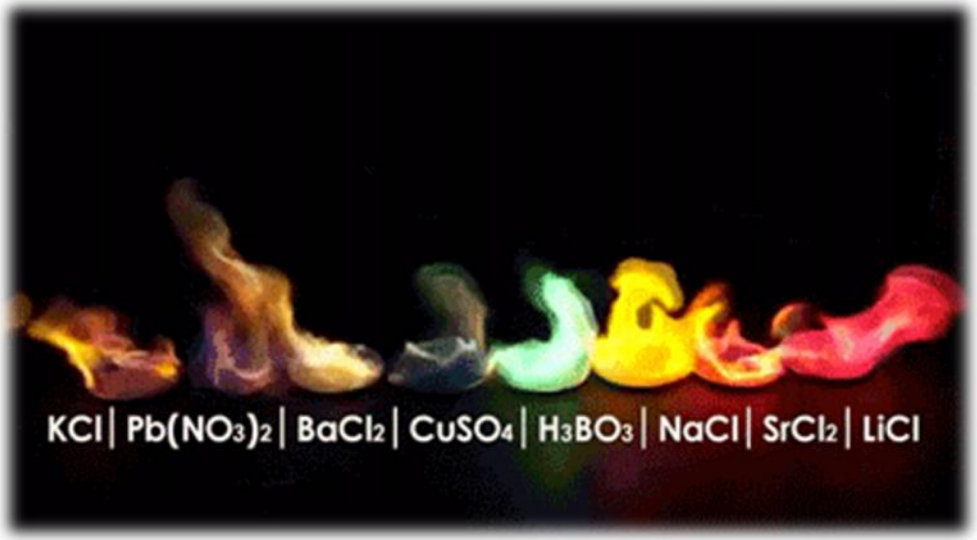
NATURE OF FIRE



Different Types Of Fire Color will Differentiate Temperature Of The Fire

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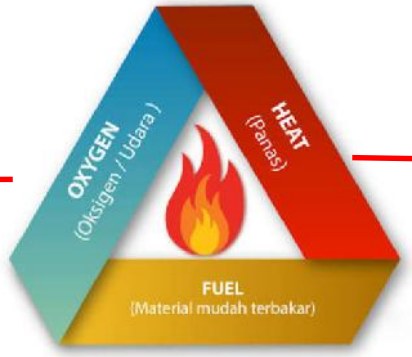
STRUCTURE OF FIRE



OXYGEN SOURCE

APPROCIMATELY 16% REQUIRED

*Normally air contains 21% O2. Some fuels contain enough oxygen within their make-up to support burning.

OXYGEN SOURCE

TO REACH IGNITION TEMPERATURE

- Open Flame- The Sun.
- Hot Surface.
- Sparks and Arcs.
- Friction-Chemical Action.
- Electrical Energy.
- Compression of Gases

PHYSICAL STATE

GASES

- Natural gas
- Propane
- Butane
- Hydrogen
- Acetylene
- Carbon Monoxide
- Others..

LIQUIDS

- Gasoline
- Kerosene
- Turpentine
- Alcohol
- Cod Liver Oil
- Paint
- Varnish
- Lacquer
- Olive Oil
- Others…

SOLIDS

- Coal
- Wood
- Paper
- Cloth
- Wax
- Grease
- Leather
- Plastic
- Sugar
- Grain
- Hay
- Cork
- Others

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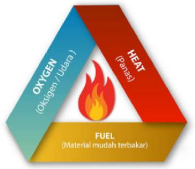
FIRE TRIANGLE COMPONENT



Fuel – Fuel can be considers as the primary element for the establishment of fire. Fuel is the element which will burn and result in the fire. The quantity of fuel will decide the duration of fire. E,g, of fuel can be any flammable material i.e. wood, paper, dry grass, solvents, plastic, petroleum products like petrol, diesel, gasoline natural gas etc.

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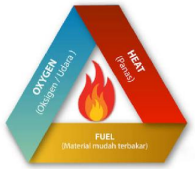
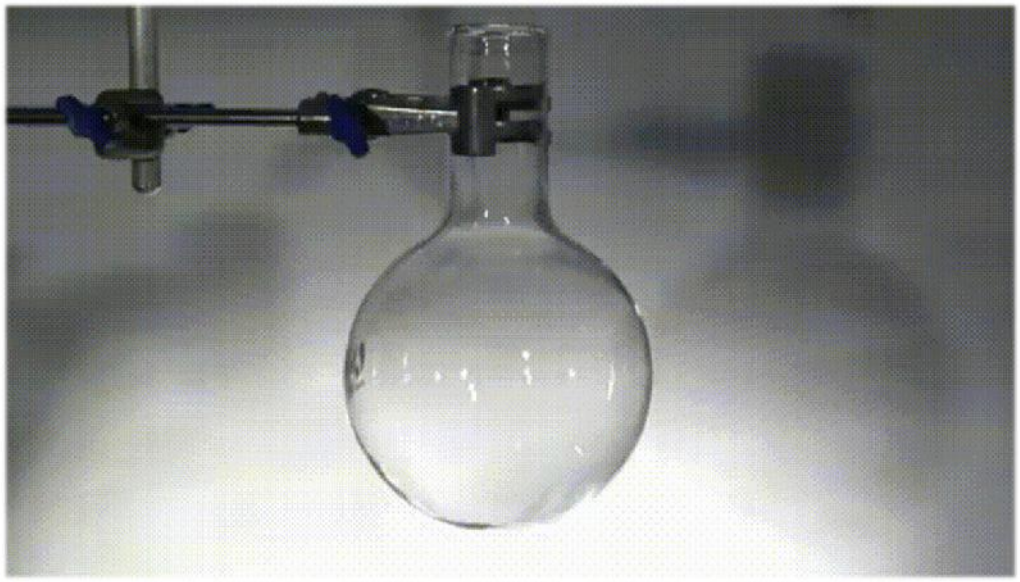
FIRE TRIANGLE COMPONENT



Oxygen / oxidizing agent – Oxygen is a element whose presence is important for fire. when fuel is burn, it react with oxygen and result in generation of release heat and generate combustion. E.g. of oxidizing agent are fluorine gas, perchlorate salts such as ammonium perchlorate, or chlorine trifluoride etc.



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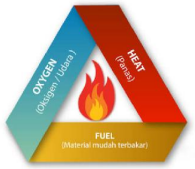
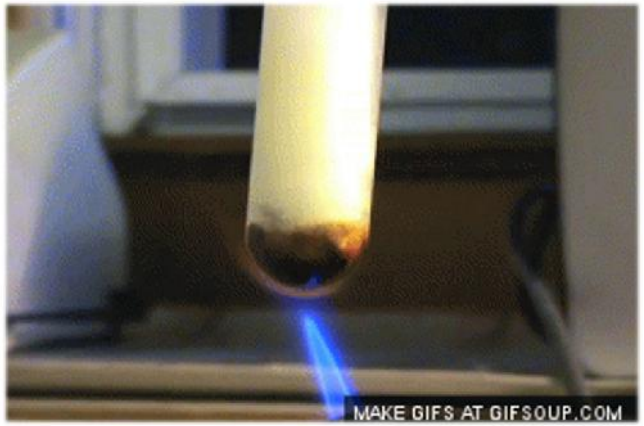
FIRE TRIANGLE COMPONENT



Ignition / Heat – All the flammable substance had flash point. Ignition in form of spark or heat is one of the tree element of the fire triangle. If in an area there is a fuel stored the atmosphere in the room has sufficient oxygen present and in this condition if



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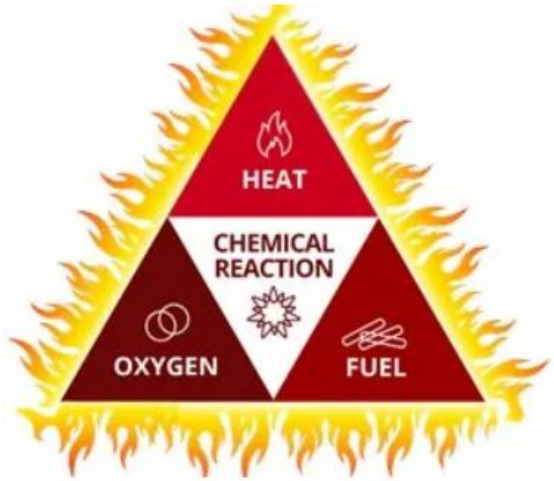
FIRE TETRAHEDRON



Since fire is an oxidation reaction, the Fire Tetrahedron is an important way to think about what is happening.

The four component required for a fire are:

- Fuel
- Oxidizing Agent
- Heat; and
- **Uninhibited Chemical Chain Reaction**

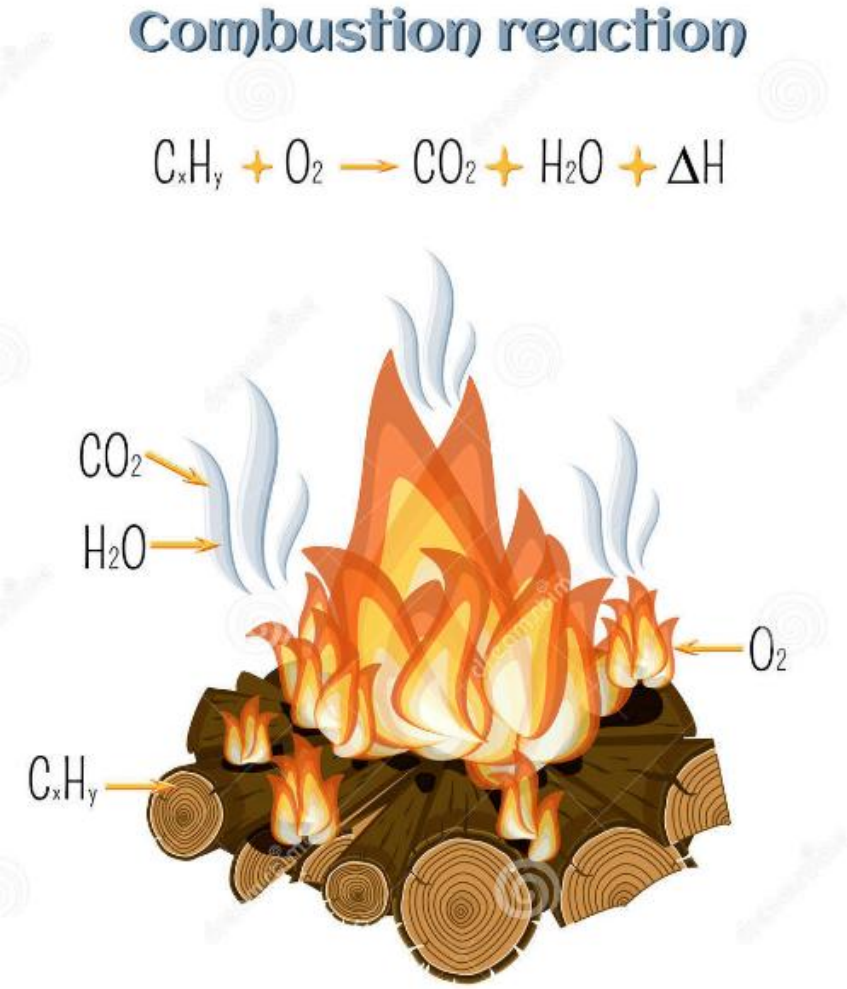
For the fire to continue burning, all four sides of the Tetrahedron must be present in the right combinations.

In other words, removing any one of the four sides of the tetrahedron will extinguish the fire. Knowing this enables us to begin explain many different aspects of fire

SISTEM PENCEGAH KEBAKARAN (ASAS)

FIRE TETRAHEDRON

- The additional element to fire triangle is ***Uninhibited Chemical Chain Reaction.***
- Its provides sufficient exothermic reaction energy to produce ignition.
- The fuel/air ratio must within flammable limits which describes the amount of vapor in air necessary to propagate flame.
- Removing any of this will suppress, or control the fire



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FIRE TETRAHEDRON

What is Exothermic Reaction ?

Define - Reaction in which heat is given out along with the product are called exothermic reaction.

Ex - Burning of coal

$$C + O_2 = CO_2 + Heat$$

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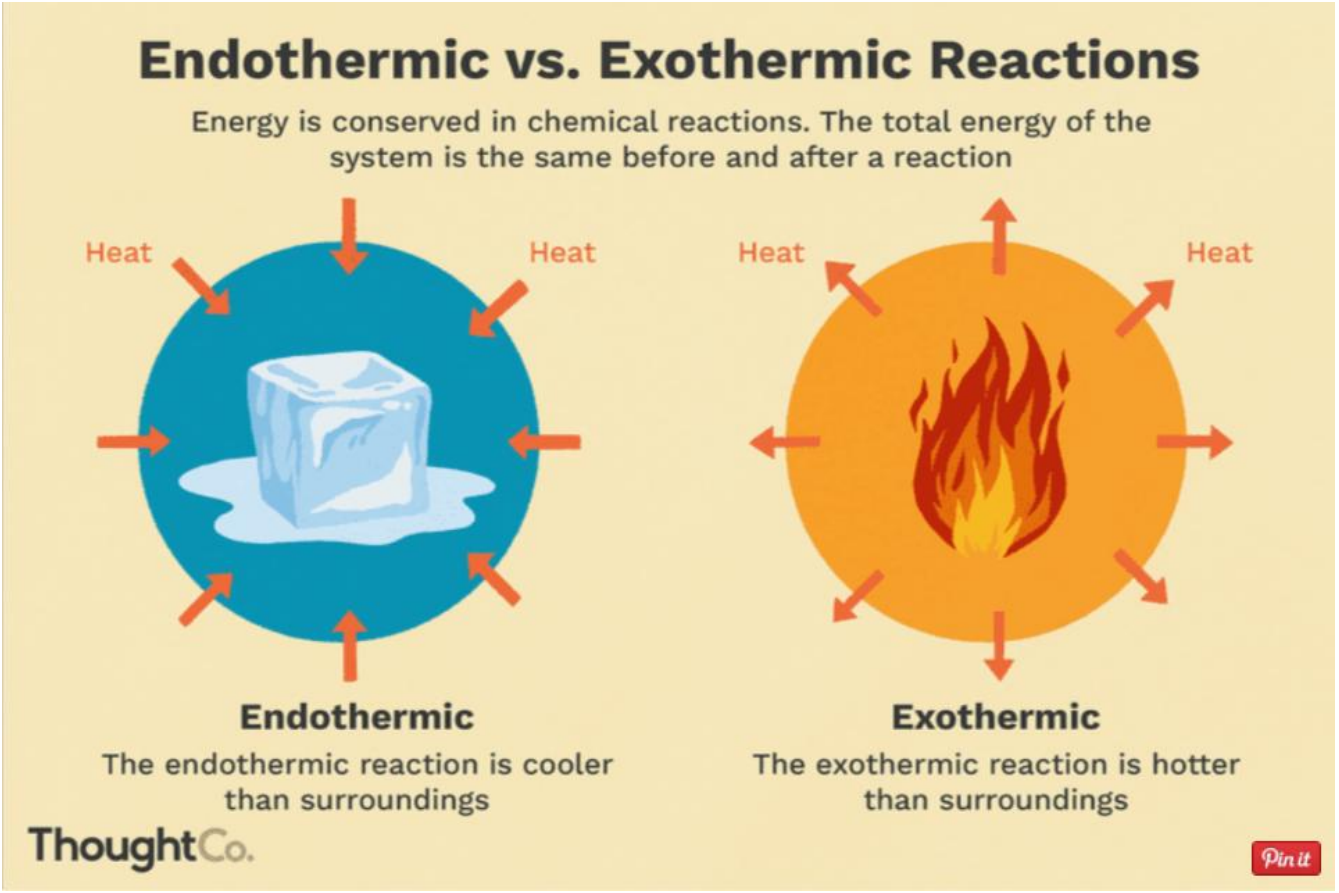
FIRE TETRAHEDRON



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STAGE OF FIRE

As fire broke out in any workplace, and if we breakdown fire then this can be known there are 4 stages of a fire. International Fire Service Training Association (IFSTA) had stated that there are 4 stages of fire. All the stages of fire are enlisted below;

- **Incipient/ Ignition**
- **Growth**
- **Fully Developed**
- **Decay**

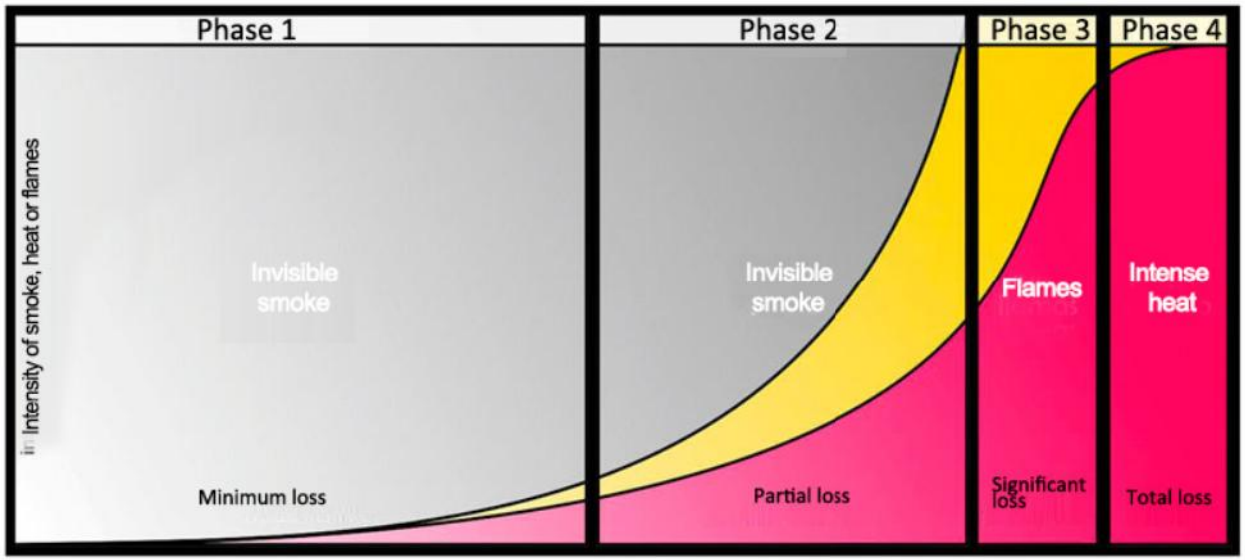

Fig 1: PHASE OF TYPICAL FIRE

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STAGE OF FIRE

1. INCIPIENT

- Incipient is known as the first stage of fire.
- This incipient stage of fire is also known as ignition.
- This is the initial stage in which fire is in smallest phase which provides the golden opportunity to take action and suppress the fire.
- This is the stage in which the fire is at initial level and one can take measures and stop the fire to get into other stage and one can avoid the fire accident.

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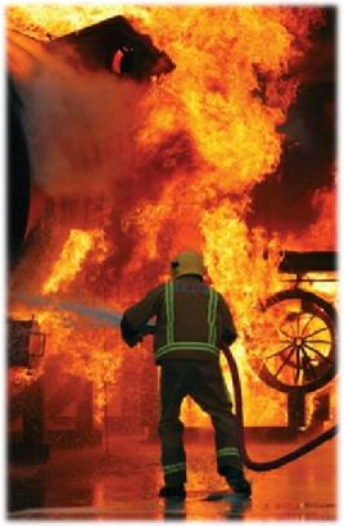
STAGE OF FIRE

2. GROWTH

- Fire if not controlled at the incipient/ignition stage then it converts to second stage that is Growth Stage of fire.
- During this stage, fire keep on consuming combustible material as a fuel and presence of oxygen to multiply its growth and this result in conversion of fire stage from incipient to growth.
- This is the shortest and most dangerous stage as sometimes within fraction of seconds fire from just ignition turn into huge fire.
- This stage is mostly responsible of trapping of persons and firefighter.



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STAGE OF FIRE

3. FULLY DEVELOPED

- After Growth stage of fire, when all the combustible material caught fire and the growth stage has reach its maximum potential that stage of fire is considered as Fully Developed.
- The Temperature at this stage is maximum among all stages of fire and it is the dangerous stage for firefighter or personnel trapped in the affect site as leaving affected site during this stage of fire is very difficult.

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STAGE OF FIRE

4. DECAY

- Last stage and longest stage of a fire is Decay Stage.
- In this stage, all the fuel present at site get burned or the present of oxygen get decrease which result in fire to be put in final point.
- Special observation and care to be taken in this fire stage also as fire is stopped or getting slowdown by reduction of fuel or insufficient oxygen.
- There is always a chance that the oxygen get rushed to the affected site or presence of combustable material left that be potential to reinitiate fire.

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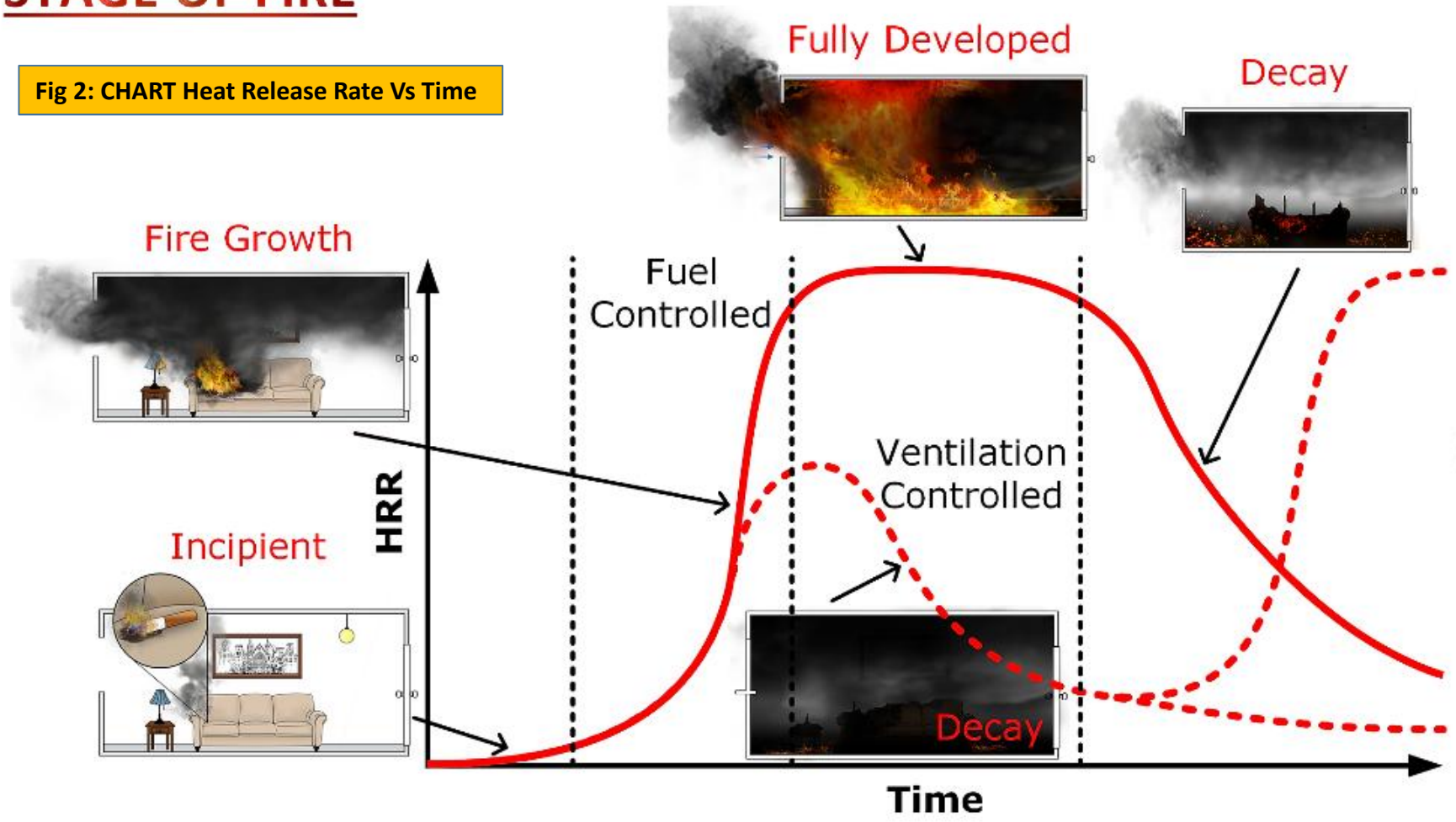
STAGE OF FIRE

Fig 2: CHART Heat Release Rate Vs Time



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FIRE CLASS

- Fire Class is a term used to denote the type of fire, in relation to combustion materials, that has (or could be) ignited. This affect the type of suppression or extinguishing material that can be used.

- Class letters are often assigned to the different types of fire, but this differ between territories. There are separate standards in US, Europe, and Australia.

Fire Class	Symbol
A	
B	
C	
D	
E	
F	

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FIRE CLASS

CLASS A

- Class A fires are defined as Ordinary Combustibles.
- These types of fires use commonly flammable material as their fuel source such as wood, paper, cloth, rubber, trash and many plastics.
- There is essentially the common accidental fire encountered across several different industries.
- Class A fires are commonly put out with water or monoammonium phosphate.

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FIRE CLASS

CLASS B

- Class B fire is defined as one that uses a flammable liquid or petroleum oil as it fuel based.
- Common liquid based fuel sources include petroleum oil based (i.e petrol, diesel, kerosene, lubricant, etc.), greases, tar, alcohol, certain types of paints.
- Monoammonium phosphate effectively smothers the fire, while sodium bicarbonate (foam type) induces a chemical reaction which extinguishes the fire.
- **NOTE:** ***Cooking Oil and Grease fire are not classified in this Class of fire since it have their own classification.***

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FIRE CLASS

CLASS C

- Class C fire is defined as one that uses a flammable gas or liquid gas as its fuel base.
- Flammable gases such as Methane, butane, propane, LPG, LNG, Hydrogen, Ammonia are also common fuel source in Class C fires.
- Monoammonium phosphate effectively smothers the fire, while sodium bicarbonate (foam type) induces a chemical reaction which extinguishes the fire.

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FIRE CLASS

CLASS D

- Class D fire is defined as one that uses a combustible metal as its fuel source.
- Examples of such combustible metals include titanium, magnesium, aluminum, potassium. (Note that there are also other metals with combustive properties we may encounter in industry)
- Class D fire are a danger in laboratory environments.
- When confronted with such a fire, common extinguishing agents such as water are ineffective and can be hazardous.
- To extinguish a Class D fire, dry powder agent is effectively smoothers the fire. This agent will absorb the heat that the fire requires to burn the metal.

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FIRE CLASS

CLASS E

- Class E fire is defined as a fire that uses electrical components and/or energized equipment as its fuel source.
- Electrical fire are often fueled by computer, servers, motors, appliances, and electronic transformers.
- Electrical fires are common in industries that deal with energy or make use of heavy electrical-powered equipment.
- However, electrical fires can occur on smaller scales in all businesses (i.e overloaded surge protector or bad wiring) and should be taken seriously.
- To extinguish such fires we must cut the power off and use non-conductive chemical to extinguish the fire.

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FIRE CLASS

CLASS F

- Class F fire is defined as a cooking fire involving combustion from liquids used in food preparation. (Normally located in commercial kitchens.)
- Greases, cooking oils, vegetable fat, and animal fat are all fuel sources found in Class F fires.
- Though such fires are technically a subclass of the flammable liquid/gas class, the special characteristic of these types of fires, namely the higher flash point, are considered important enough to recognize separately.
- A Wet Chemical fire extinguisher have become popular in putting out these types of fires.
- A water mist can also be used to extinguish such fires.
- Sometimes fire blankets are used to stop a fire in a kitchen or on stove.
- Note: As with Class B fires, a solid stream of water should never be used to extinguish this type of fire because it can cause the fuel to scatter, spreading the flames.

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FIRE CLASS

Image	Description	Europe (European Standard EN 2)	United States	Australian	Suitable suppression
	Combustible materials (wood, paper, fabric, refuse)	Class A	Class A	Class A	Most suppression techniques
	Flammable liquids	Class B	Class B	Class B	Inhibiting chemical chain reaction, such as dry chemical or Halon
	Flammable gases	Class C	Class B	Class C	Inhibiting chemical chain reaction, such as dry chemical or Halon
	Flammable metals	Class D	Class D	Class D	Specialist suppression required
	Electrical fire	*not classified (formerly Class E)*	Class C	Class E	As ordinary combustibles, but conductive agents like water not to be used
	Cooking oils and fats	Class F	Class K	Class F	Suppression by removal of oxygen or water mist

Fig 3: Fire Class Comparison Between Country (US vs Europe vs Australia)

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CATEGORY OF FIRE PROTECTION SYSTEM

PASSIVE FIRE PROTECTION SYSTEM

SCOPE IS UNDER ARCHITECT & STRUCTURE ENGINEER

REQUIREMENT ACCORDING UBBL 5TH SCHEDULE

- Fire appliances access
- Wall & Floor
- Escape Route
- Door (Fire rated)
- Staircase
- Lobby
- Natural Ventilation
- Emergency Signage

ACTIVE FIRE PROTECTION SYSTEM

SCOPE IS UNDER MECHANICAL & ELECTRICAL ENGINEER

REQUIREMENT ACCORDING UBBL 10TH SCHEDULE

CATEGORY

- **FIXED Installation**
  - ✓ Hose Reel, Sprinkler, Dry & Wet Riser System
- **PORTABLE Installation**
  - ✓ Portable Fire Extinguisher, Sand Basket
- **ALARM, Signal & Other Equipment**
  - ✓ Fire Alarm, Smoke Detector, Heat Detector, Alarm Bell, Emergency Light

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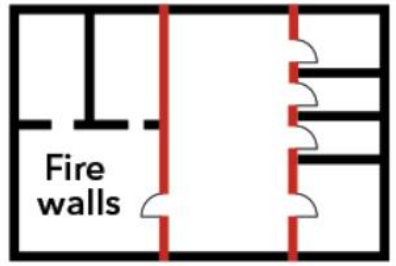
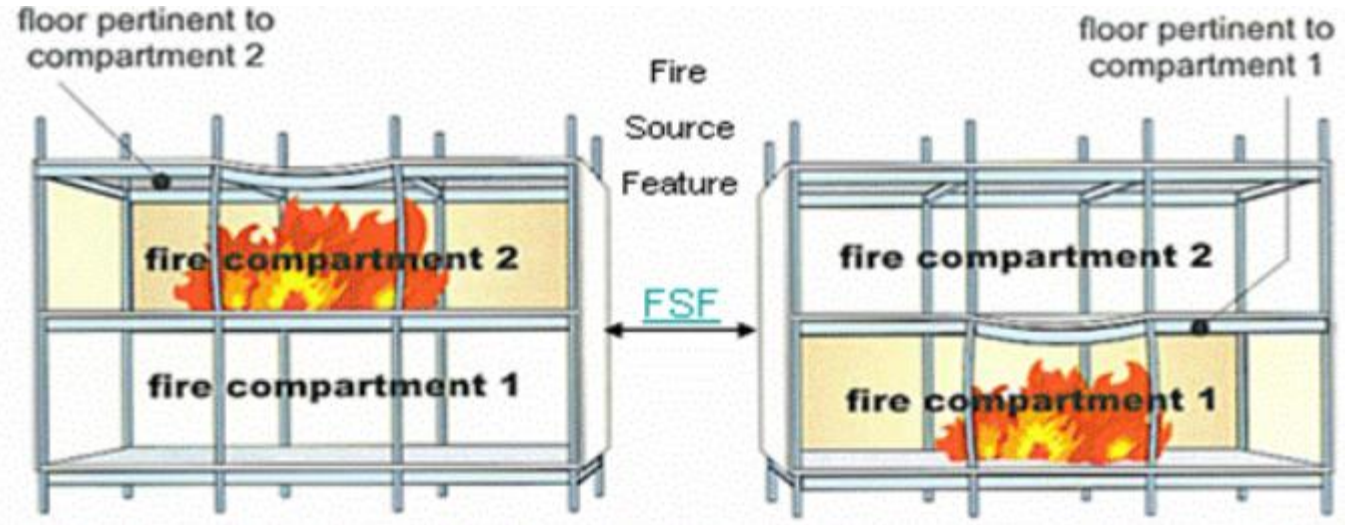
PASSIVE FIRE PROTECTION

PURPOSED

Passive Fire Protection is based on structural fire protection and compartmentation and allows safe exit of occupants out of the building and entrance of the fire brigade into the building.





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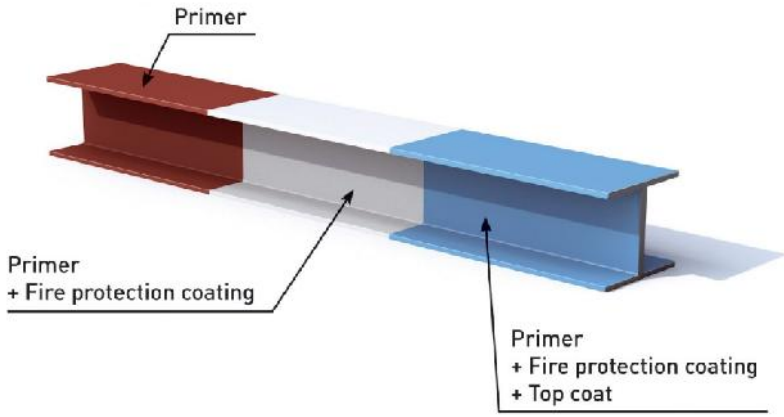
PASSIVE FIRE PROTECTION

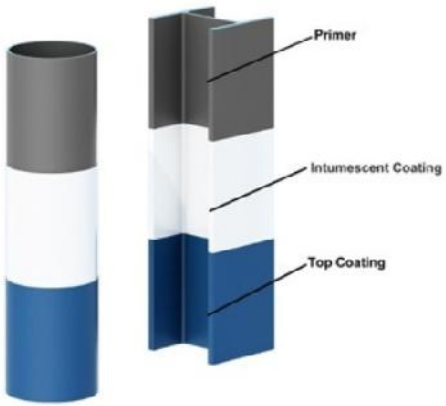
STRUCTURAL FIRE PROTECTION

To ensures the stability of structural elements such as steel/timber beams and steel/timber columns in building in case of fire.



This is achieved by applying adequate products onto the structural element, such as;

- Boards
- Paints
- Sprays



Intumescent Steel Fireproofing

Unprotected steel

At a critical temperature of 500 °C steel loses its strength. Fire resistance may be far les than 30 minutes.

Steel protected with intumescent coating

Typical application of an intumescent coating done by airless-spray, brush or roller.

Steel protected with intumescent coating in a fire scenario

Steel with intumescent coating fulfills the official test requirements for 30, 60, 90, 120, 180 minutes.

SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

COMPARTMENT FIRE PROTECTION

A Compartment is a defined space in building, which limits the spread of fire and smoke. The size and number of compartments are defined in all national building codes dependent on;

- Floor Area or volume;
- The amount of combustible materials in each level

Note: Building Code differ from one country to another.

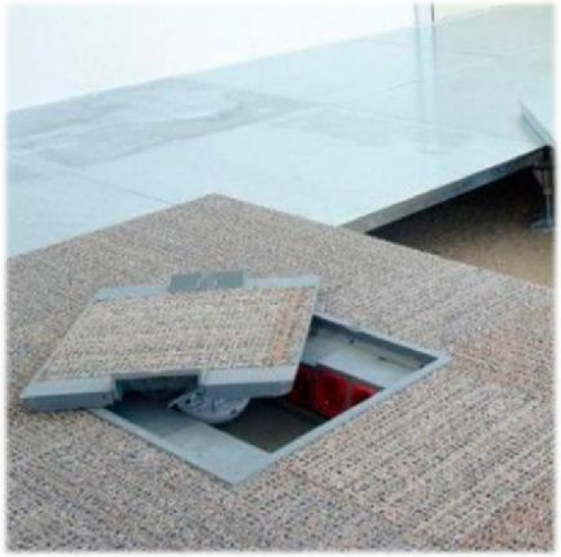
SISTEM PENCEGAH KEBAKARAN (ASAS)

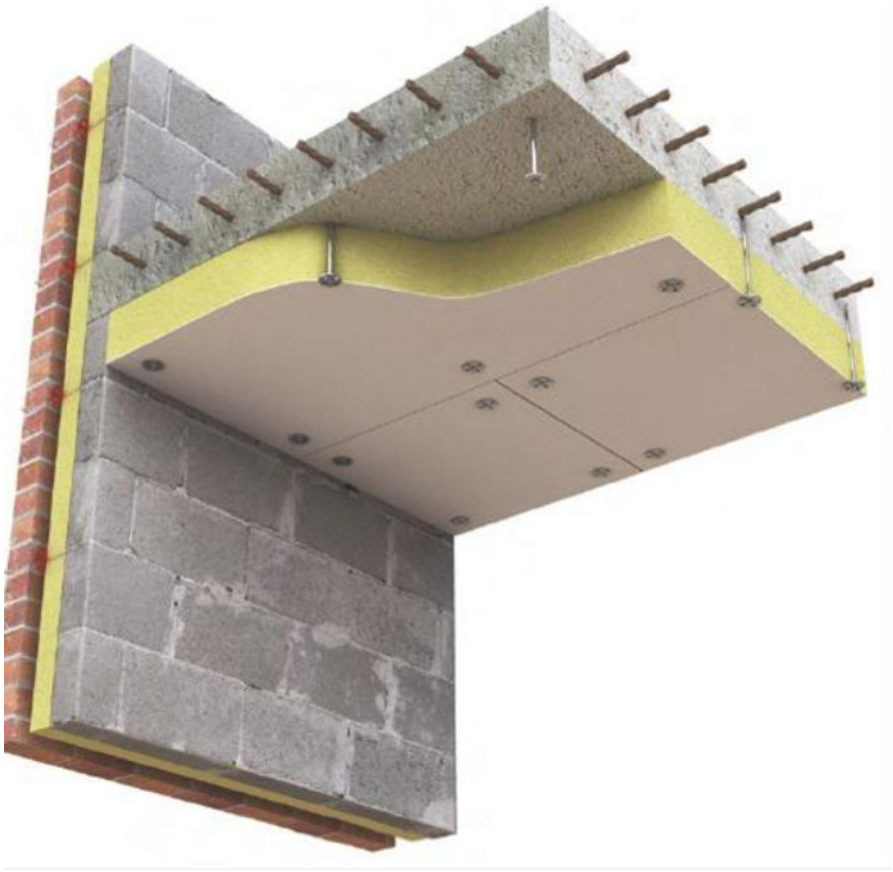
PASSIVE FIRE PROTECTION

COMPARTMENT FIRE PROTECTION

Compartments are always;

- **Vertical – Fire rated floors/ceilings**
- **Horizontal – Fire rated walls**





SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

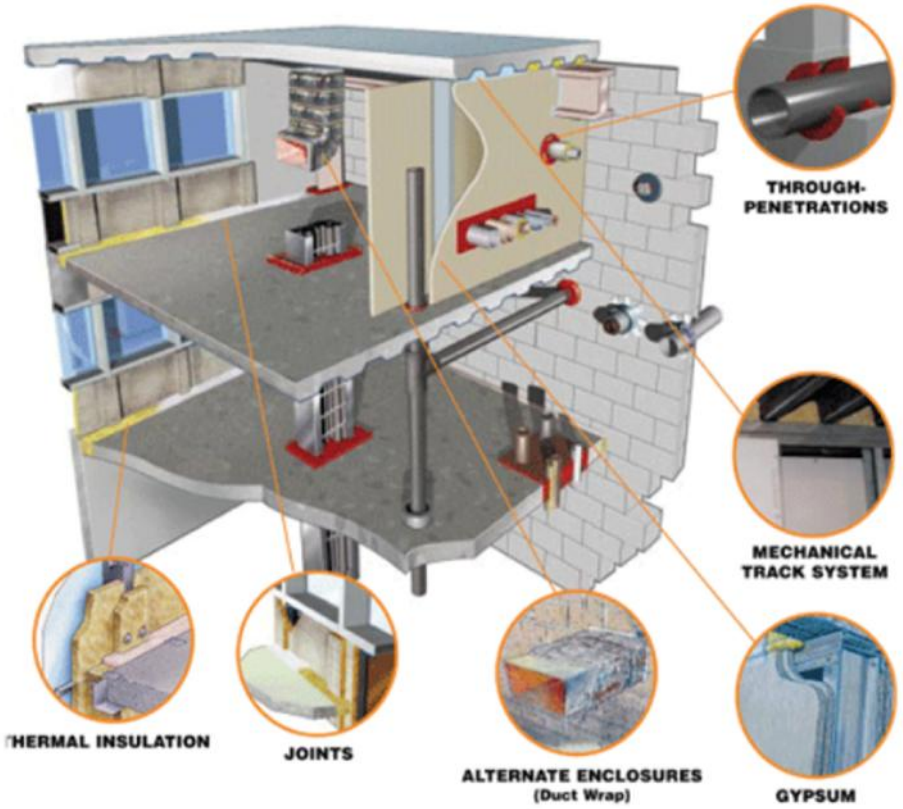
COMPARTMENT FIRE PROTECTION

All kinds of service are required in such boxes then certain openings are created, which have also to be protected.

An obvious and always visible is a fire door.

But also where all other services such as cable, pipes, ducts, etc. are running through structure, the tightness of the compartment has to be ensured again by installing adequate penetration seals.

This Penetration seals are mostly a combination of several product such as coatings, mortars, collars, wraps, sealants and backfilling material.



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PASSIVE FIRE PROTECTION

FIRE RESISTANCE LEVEL (FRL)

The FRL is the ability of a building element to withstand a fire under test conditions for a certain period of time and consists of three criteria listed below;

- **Ingegrity (E)**
- **Insulation (I)**
- **Structural Adequacy/Load Bearing Capacity (R)**

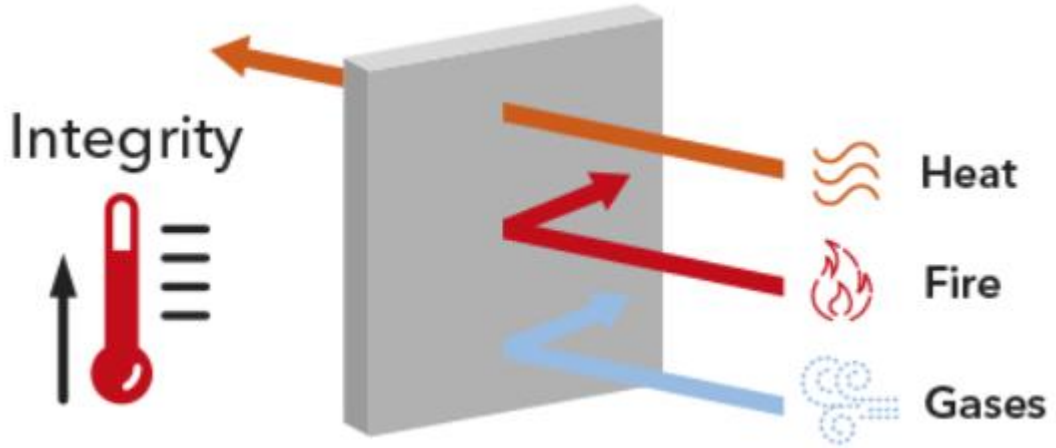
SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

FIRE TEST:

- **INTEGRITY (E)**

The ability to resist the passage of flames and hot gases as specified by Code Of Standard (e.g BS 476/ AS1530).



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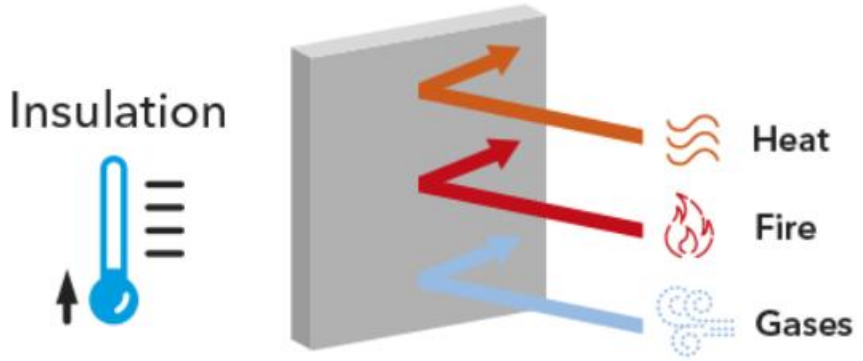
PASSIVE FIRE PROTECTION

FIRE TEST:

- **INSULATION (I)**

This abilitiy to maintain a temperature over the whole of the exposed surface below the specified maximum temperature in the standard. (Thermal insulation means the maximum temperature of 180°C).



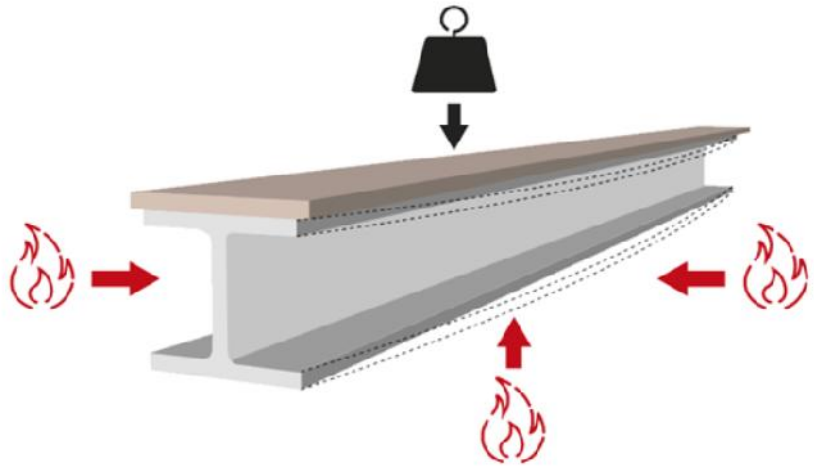
SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

FIRE TEST:

- **LOAD-BEARING CAPACITY (R)**

The ability to maintain stability and adequate load bearing capacity as determined by the standard.



SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

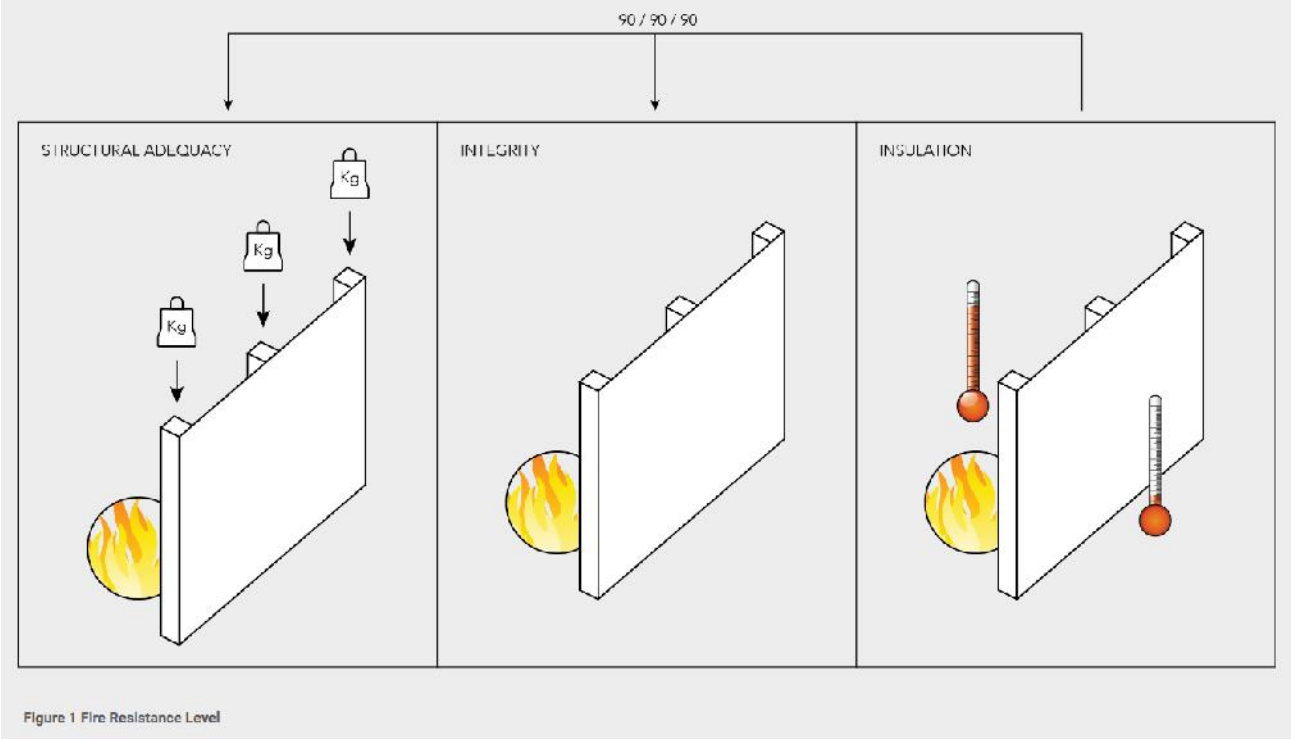


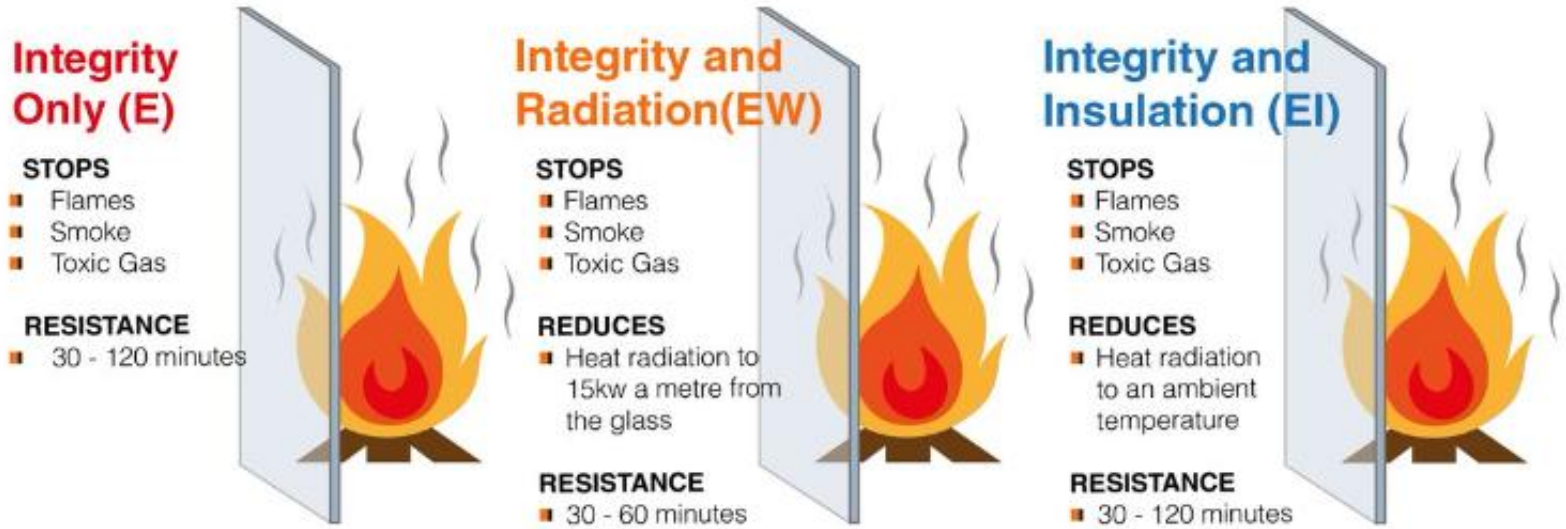
Figure 1 Fire Resistance Level

Example: Figure 1 above show a FRL of 90/90/90, meaning a failure would not be expected within 90 minutes of each of the three criteria

SISTEM PENCEGAH KEBAKARAN (ASAS)

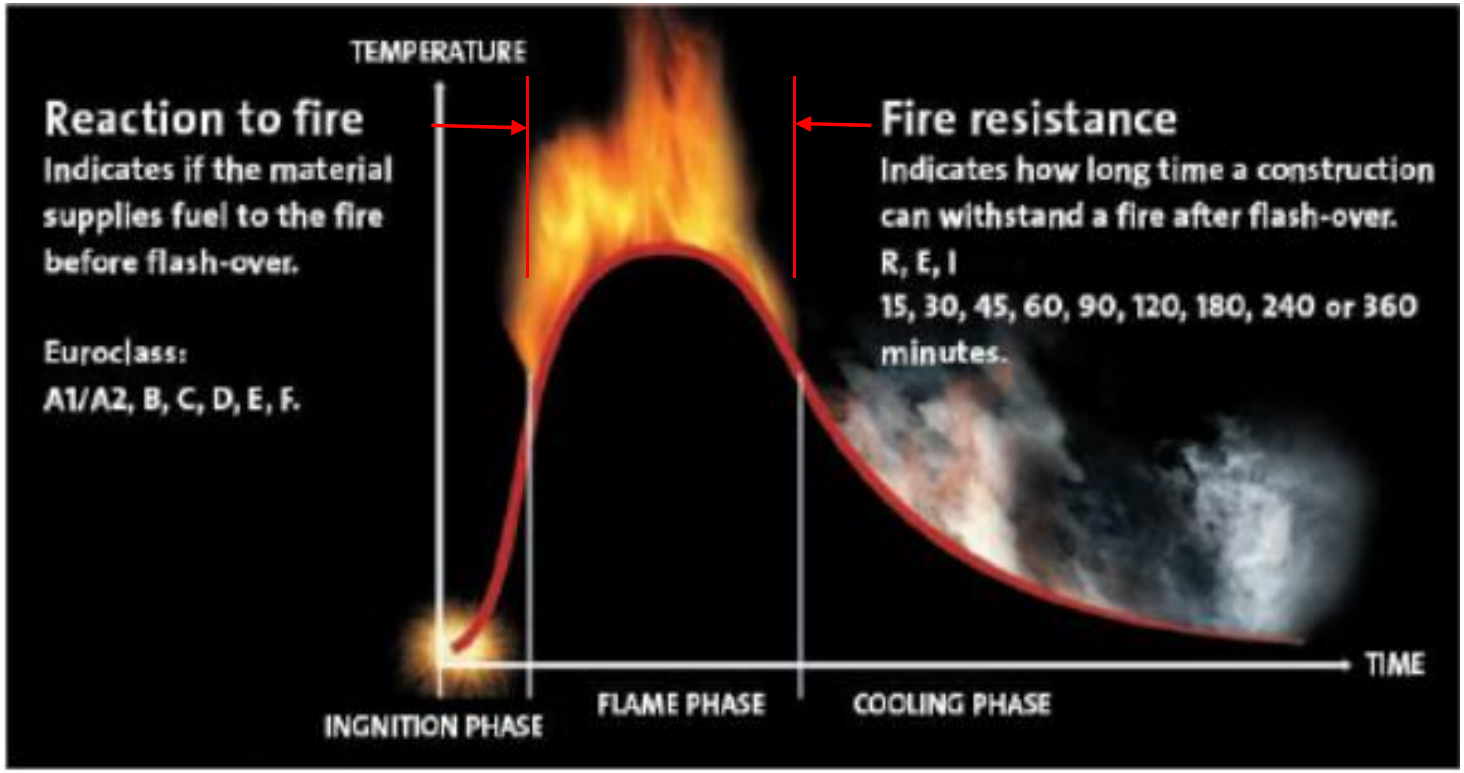
PASSIVE FIRE PROTECTION

FIRE RATINGS



SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION



SISTEM PENCEGAH KEBAKARAN (ASAS)

PASSIVE FIRE PROTECTION

WHAT IS THE DIFFERENCE BETWEEN FIRE RESISTENCE AND REACTION TO FIRE?

- **FIRE RESISTENCE**

Is maintaining the structural stability or preventing the spread of fire from one compartment to another as is tested for every system

- **REACTION TO FIRE**

Is a measures the material behavior per product and how it contributes to the growth of fire.

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

PURPOSED

Active Fire Protection is a group of system that require some amount of action or motion in order to work efficiently in the event of fire.

In Layman's Term;

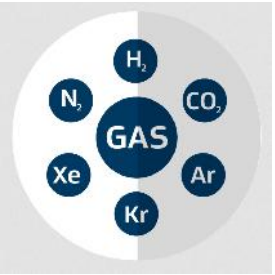
- **To Detect**
- **To Alert about**
- **To Seek and eliminate the fire hazard**

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

CATEGORY

- ❑ **WATER BASED SYSTEM**
- ❑ **NON WATER BASED SYSTEM**
- ❑ **ALARM & DETECTION SYSTEM DEVICE**
- ❑ **SMOKE CONTROL SYSTEM**



SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

CATEGORY

- ❑ **WATER BASED SYSTEM**

Sprinkler System

Dry Riser System

Portable Fire Extinguisher System

Fire Hydrant System

Hose Reel System

Wet Riser System

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

NON WATER BASED SYSTEM

Portable Fire Extinguisher System

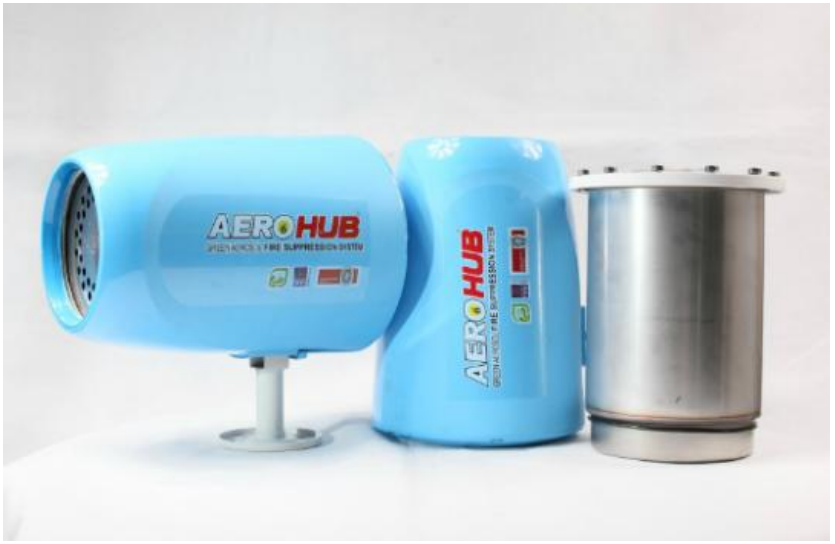
Gas Fire Suppression System

Wet Chemical System

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

NON WATER BASED SYSTEM (OTHERS)



Aerosol Fire Extinguisher System

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

NON WATER BASED SYSTEM (CONVENTIONAL TYPE)

Sand Fire Bucket System

Fire Blanket System

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

FIRE DETECTOR

Smoke Detector

Heat Detector

Flame Detector

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

ALARM SYSTEM

Break Glass

Fire Alarm Bell

Fire Alarm Sounder

Fire Strobe Light

Fire Flash Light

SISTEM PENCEGAH KEBAKARAN (ASAS)

ACTIVE FIRE PROTECTION

OTHER ACTIVE FIRE SYSTEM

Smoke Detector

Electrical Lighting Signage

Emergency Voice Communication System

SISTEM PENCEGAH KEBAKARAN (ASAS)

SKOP KURSUS

Portable Fire Extinguisher System

Fire Alarm System

ACTIVE FIRE PROTECTION SYSTEM

Dry Riser System

Fire Suppression Extinguishing System

Hose Reel System

Wet Riser System

SISTEM PENCEGAH KEBAKARAN (ASAS)

SISTEM PENCEGAH KEBAKARAN (ASAS)