



# **Process Control and Building Management Systems**

EME501

## **Lec14 Air Conditioning and Fire Fighting Systems**

# **INSTRUCTOR**

# **DR / AYMAN SOLIMAN**

## ➤ Introduction

- **Air conditioning** is the process of removing heat and moisture from the interior of an occupied space to improve the comfort of occupants.
- Air conditioning can be used in both **domestic** and **commercial** environments.
- This process is most used to achieve a more comfortable interior environment, typically for **humans** and other **animals**; however, air conditioning is also used to **cool** and **dehumidify** rooms filled with heat-producing electronic devices, such as computer servers, power amplifiers.




## ➤ Introduction (cont.)

- Air conditioners often use a fan to distribute the conditioned air to an enclosed space such as a building or a car to improve thermal comfort and indoor air quality.
- Electric refrigerant-based AC units range from **small units** that can cool a small bedroom, which can be carried by a single unit, to **massive units** installed on the roof of office towers that can cool an entire building.
- A complete system of **heating, ventilation, and air conditioning** is referred to as **HVAC**. As of 2018, **1.5 billion** air conditioning units were installed, with the International Energy Agency expecting **5.6 billion** units in use by 2050. Globally, current air conditioning accounts for **1/5** of energy usage in buildings globally, and the expected growth of the usage of air conditioning, will drive significant energy demand growth.



## ➤ Electrical air conditioning History

- The creation of the modern electrical air conditioning unit and industry is credited to the American inventor **Willis H. Carrier**. 
- The first air conditioner, designed and built in Buffalo, New York by Carrier, began working on 17 July 1902.
- Designed to **improve** manufacturing **process control in a printing plant**, Carrier's invention controlled not only **temperature** but also **humidity**.
- Later, Carrier's technology was applied to increase productivity in the workplace, and The Carrier Air Conditioning Company of America was formed to meet rising demand. Over time, air conditioning came to be used to improve comfort in **homes** and **automobiles** as well.



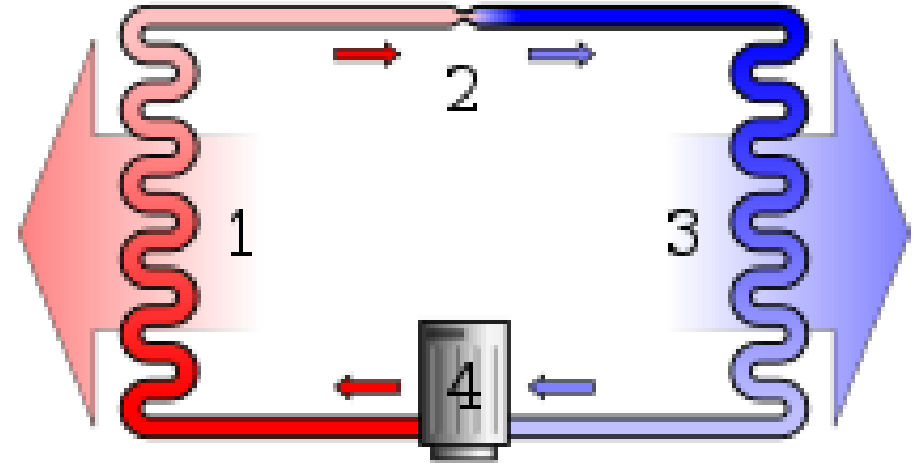
## ➤ Refrigerant development

- The first air conditioners and refrigerators employed **toxic** or **flammable** gases, such as **ammonia**, **methyl chloride**, or **propane**, that could result in fatal accidents.
- **Thomas Midgley, Jr. created** the first non-flammable, non-toxic chlorofluorocarbon gas, Freon (R-12), in **1928**.
- The name is a trademark name owned by DuPont for any chlorofluorocarbon (CFC), hydrochlorofluorocarbon (HCFC), or hydrofluorocarbon (HFC) refrigerant.
- The refrigerant names include a number indicating the molecular composition (e.g., R-11, R-12, R-22, R-134A). The blend most used in direct-expansion home and building comfort cooling is an HCFC known as chlorodifluoromethane (**R-22**).



## ➤ Refrigeration cycle

- **Cooling** in traditional AC systems is accomplished using the **vapor-compression cycle**, which uses the forced circulation and phase change of a refrigerant between gas and liquid to transfer heat.
- The vapor-compression cycle can occur within a **unitary**, or **packaged** piece of equipment; or within a chiller that is connected to terminal cooling equipment on its evaporator side and heat rejection equipment on its condenser side.



A simple stylized diagram of the refrigeration cycle:

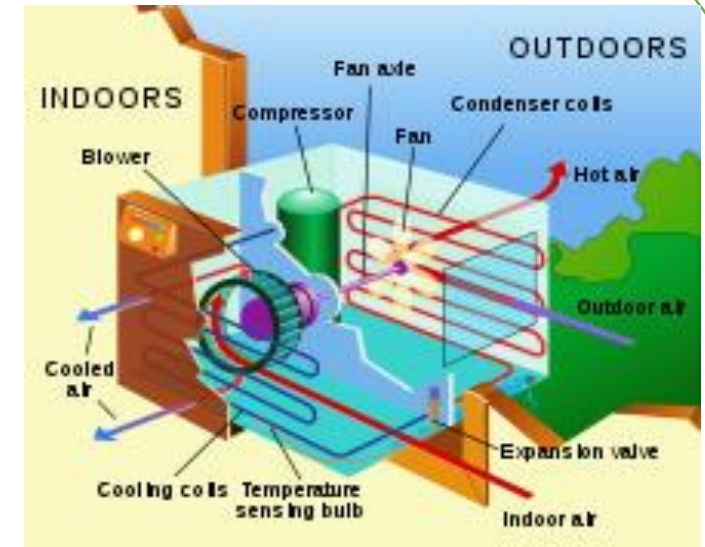
- 1) [condensing coil](#), 2) [expansion valve](#),
- 3) [evaporator coil](#), 4) [compressor](#)



# Installation types

## ➤ 1) Window unit

➤ Window unit air conditioners are installed in an open window. The **interior air** is cooled as a fan blows it over the evaporator. On the exterior the heat drawn from the interior is dissipated into the environment as a second fan blows outside air over the condenser.



- A **large house** or building may have **several** such units, allowing each room to be cooled separately.
- In 1971, General Electric introduced a popular portable in-window air conditioner designed for convenience and portability.



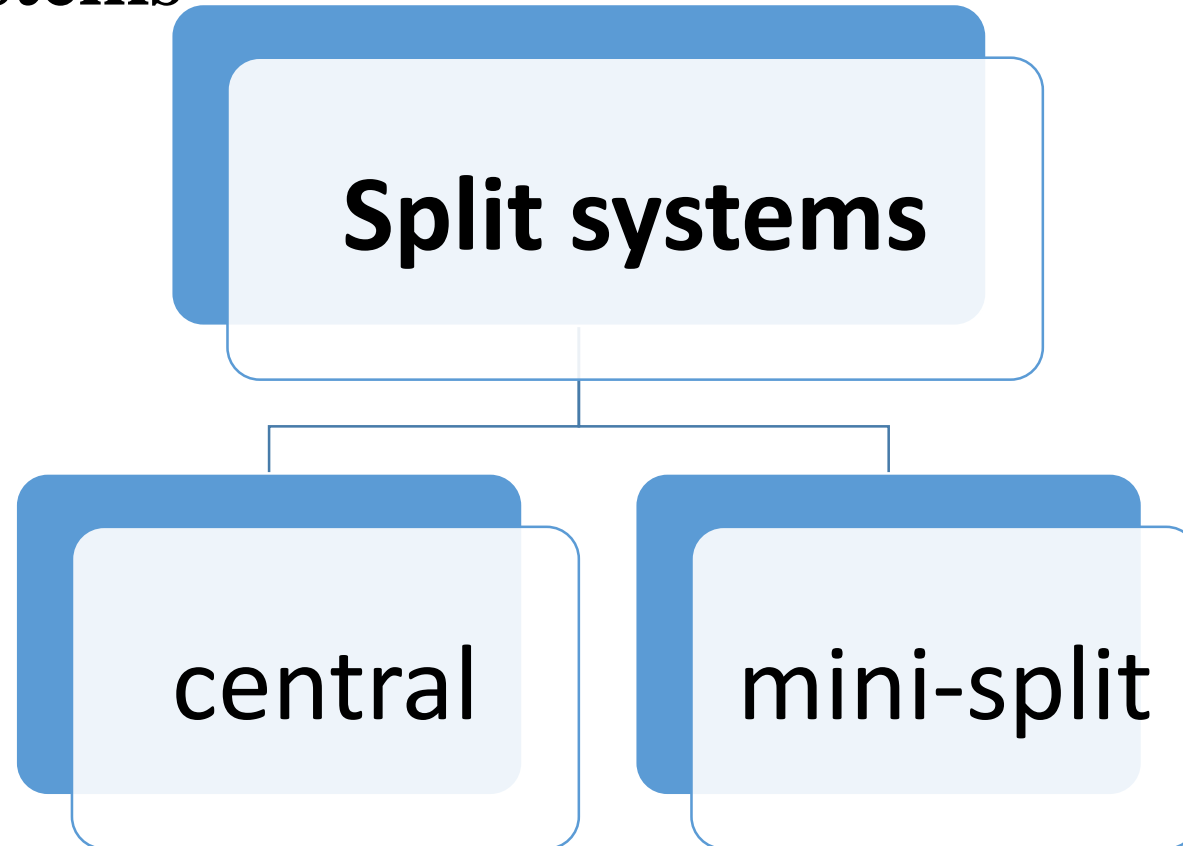
## ➤ 2) packaged terminal

➤ **Packaged terminal air conditioner (PTAC)** systems are also known as **wall-split** air conditioning systems. PTACs, which are frequently used in hotels, have two separate units (terminal packages), the **evaporative unit on the interior** and the **condensing unit on the exterior**, with an opening passing through the wall and connecting them.



➤ PTAC systems may be adapted to provide heating in cold weather, either directly by using an electric strip, gas, or other heater, or by **reversing the refrigerant flow** to heat the interior and draw heat from the exterior air, converting the air conditioner into a heat pump.

### ➤ 3) Split systems



- In both types, the inside-environment (**evaporative**) heat exchanger is separated by **some distance** from the outside-environment (**condensing unit**) heat exchanger.

## ➤ **Split central (ducted) system**

- These are used in homes and businesses. In them, the indoor unit can be an air handling unit or a fan coil unit, a mechanism to heat the air and filter is placed inside a house or building and is connected to a condensing unit, which is outdoors.
- A user sets a desired temperature on the thermostat and the thermostat controls the air handler to maintain the set temperature.

## ➤ **Mini-split (ductless) system**

- A mini-split system typically supplies air conditioned and heated air to a single or a few rooms of a building.
- The name mini-split is often used to refer to those mini-split systems that only supply air to **a single room**.
- Multi-zone systems are a common application that allow **up to 8 rooms** (zones) to be conditioned from **a single outdoor** unit.
- Multi-zone systems typically offer a variety of indoor unit styles including wall-mounted, ceiling-mounted, ceiling recessed, and horizontal ducted. Mini-split systems typically produce 9,000 to 36,000 BTU (9,500–38,000 kJ) per hour of cooling to a single room or indoor unit. The **first** mini-split systems were sold in **1954-1968** by Mitsubishi Electric and Toshiba, in Japan.

## ➤ **Process applications**

- Chemical and biological laboratories
- Cleanrooms to produce integrated circuits, in which very high levels of air cleanliness and control of temperature and humidity are required for the success of the process.
- Facilities for breeding laboratory animals. Food cooking and processing areas
- Hospital operating rooms.
- Industrial environments
- Mining
- Nuclear power facilities
- Physical testing facilities
- Plants and farm growing areas
- Textile manufacturing

## ➤ **Environmental impacts**

### ❑ **Power consumption and efficiency**

Production of the electricity used to operate air conditioners has an environmental impact, including the release of greenhouse gases.

According to a 2015 government survey, 87% of the homes in the United States use air conditioning and 65% of those homes have central air conditioning.

Most of the homes with central air conditioning have programmable thermostats, but approximately two-thirds of the homes with central air do not use this feature to make their homes more energy efficient.



# Fire Fighting Systems

# Basic Fire Fighting Training

Fire and Types  
of Fire

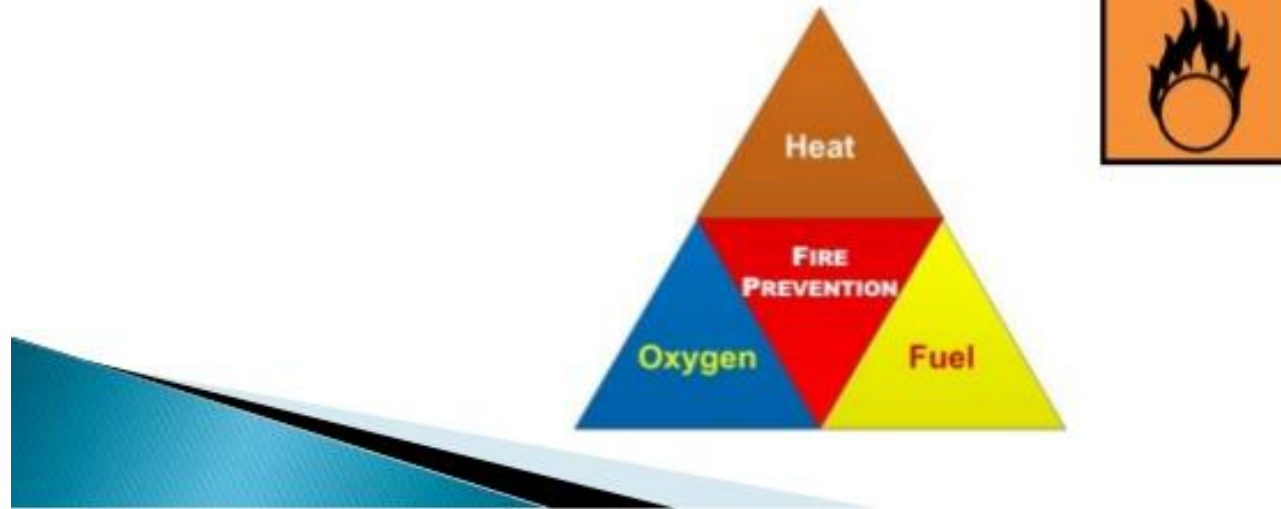
Types of Heat  
Transmission

Types of  
Extinguishing

Types of Fire  
Extinguishers

# What is **fire**?

- ▶ A process in which substances combine chemically with oxygen from the air and typically give out bright light, heat, and smoke; combustion or burning.
- ▶ Fire Triangle



# FIRE TRI ANGLE



# Classes of Fire

Classes Of Fire	Type Of Fire	Picture Symbol	Extinguisher
<b>A</b>	<b>Wood, paper, textiles, etc</b>		<ul style="list-style-type: none"> <li>■ Water</li> <li>■ Foam Spray</li> <li>■ ABC Dry Powder</li> <li>■ Class F Wet Chemical</li> </ul>
<b>B</b>	<b>Flammable Liquids</b>		<ul style="list-style-type: none"> <li>■ Foam Spray</li> <li>■ ABC Dry Powder</li> </ul>
<b>C</b>	<b>Flammable Gases</b>		<ul style="list-style-type: none"> <li>■ ABC Dry Powder</li> </ul>
<b>D</b>	<b>Metal</b>		<ul style="list-style-type: none"> <li>■ Class D Powder</li> </ul>
<b>F</b>	<b>Cooking Oil and Fat fires</b>		<ul style="list-style-type: none"> <li>■ Class F Wet Chemical</li> </ul>
	<b>Electrical</b>		<ul style="list-style-type: none"> <li>■ ABC Dry Powder</li> <li>■ Carbon Dioxide</li> </ul>

CLASSES OF FIRES	TYPES OF FIRES	PICTURE SYMBOL
<b>A</b>	Wood, paper, cloth, trash & other ordinary materials.	
<b>B</b>	Gasoline, oil, paint and other flammable liquids.	
<b>C</b>	May be used on fires involving live electrical equipment without danger to the operator.	
<b>D</b>	Combustible metals and combustible metal alloys.	
<b>K</b>	Cooking media (Vegetable or Animal Oils and Fats)	

**Class A**  
Ordinary combustibles or fibrous material, such as wood, paper, cloth, rubber, and some plastics.



**Class B**  
flammable or combustible liquids such as gasoline, kerosene, paint, paint thinners and propane

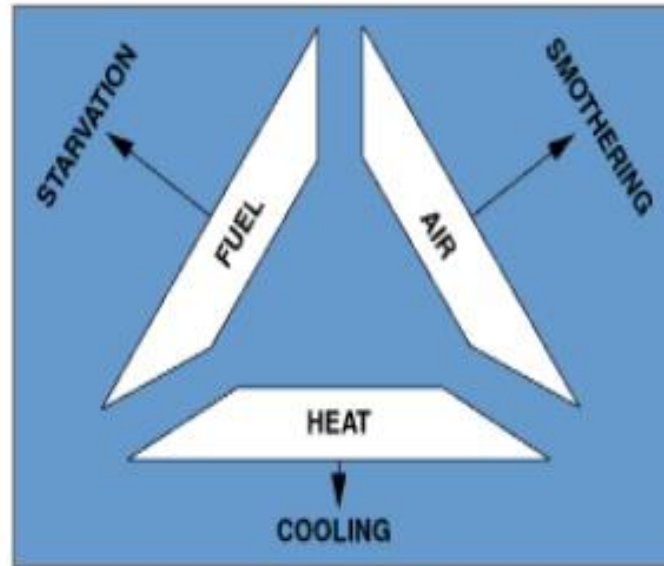
**Class C**  
Energized electrical equipment, such as appliances, switches, panel boxes and power tools.



**Class D**  
Certain combustible metals, such as magnesium, titanium, potassium, and sodium



# Types of Removing Fire



## **COOLING**

**Removal of heat.**  
**(Best cooling media is water)**

## **SMOTHERING**

**Reducing % of oxygen. Cutting off the supply of oxygen. (Blanketing, Use foam)**

## **STARVATION**

**Removal of fuel or removal of combustible material near by**

# Types of Fire Extinguishers

## Types of Fire Extinguishers

Their uses and their colour coding according to BS EN 3 : 1996.

The contents of an extinguisher is indicated by a colour zone on the body of the extinguisher.



**WATER**

For wood, paper, textile  
and solid material fire

**DO NOT USE on  
liquid, electrical or  
metal fires**



**POWDER**

For liquid and  
electric fires

**DO NOT USE on  
metal fires**



**FOAM**

For use on  
liquid fires

**DO NOT USE on  
electrical or  
metal fires**



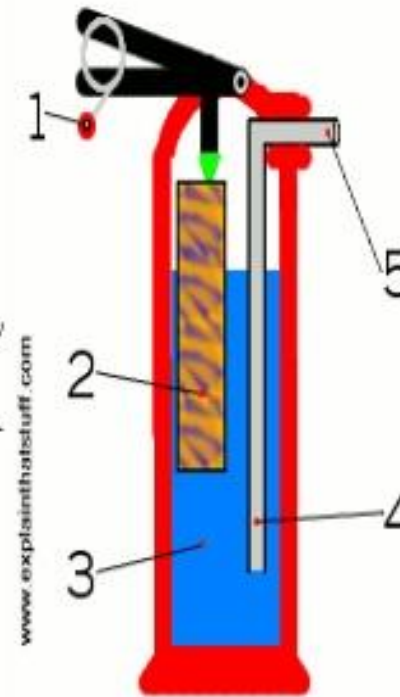
**CARBON  
DIOXIDE**

For liquid and  
electric fires

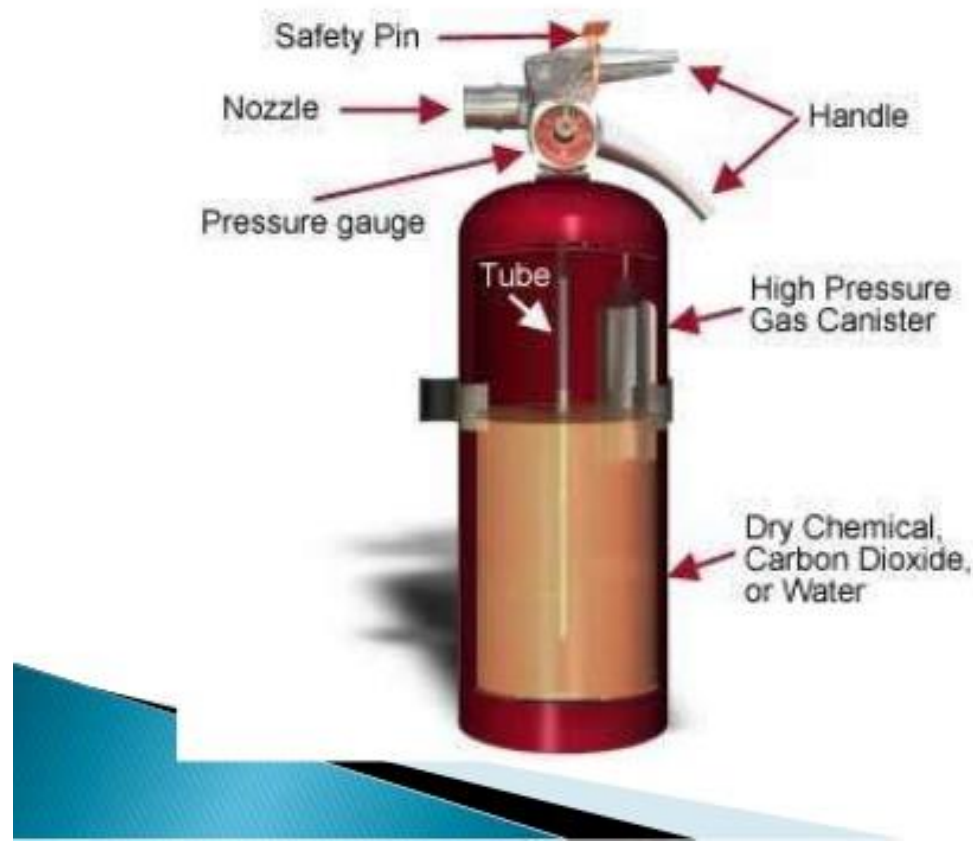
**DO NOT USE on  
metal fires**

## Water type Extinguisher

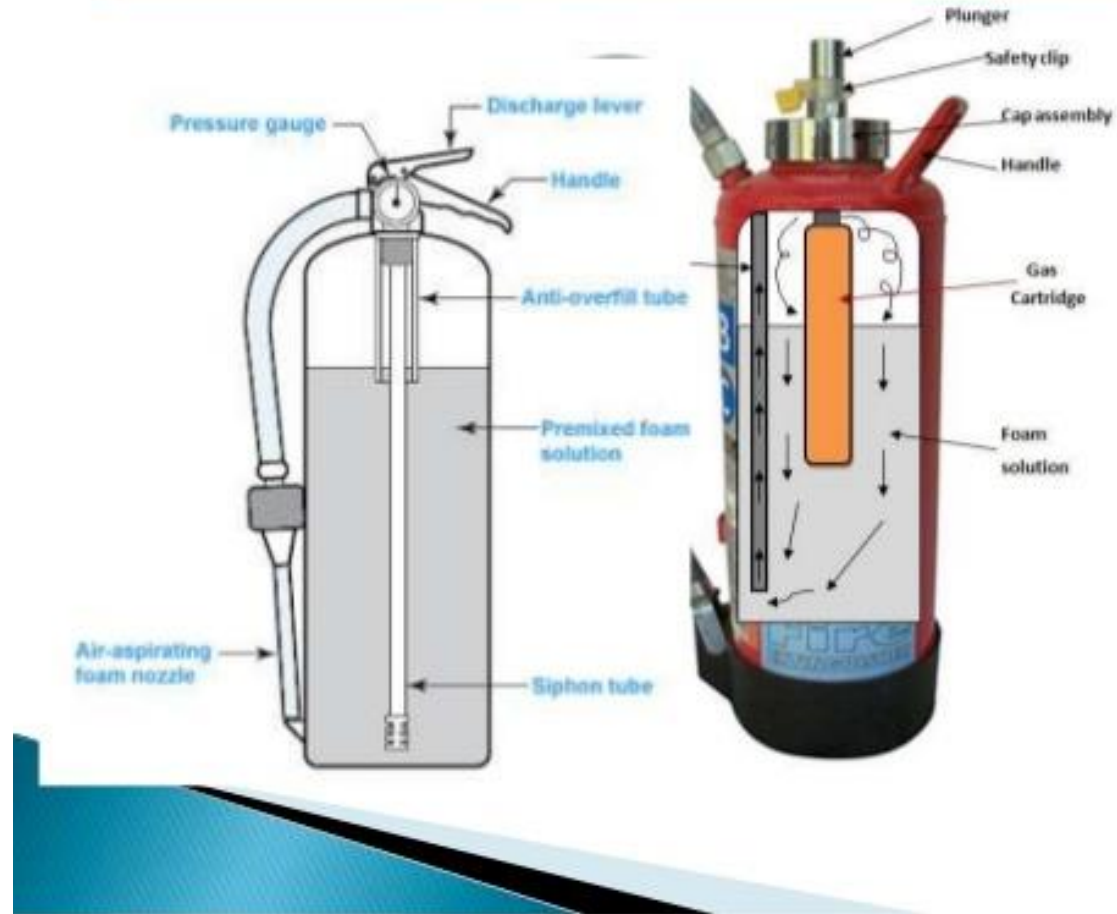
- ▶ A ring or pin on the handle stops the fire extinguisher from being set off by accident. It also acts as a tamper-proof seal: if the ring is broken or missing, you know the extinguisher needs to be checked.
- ▶ Inside the sturdy **steel** case, there's a canister containing high-pressure gas (orange with blue hashing).
- ▶ Most of the extinguisher is filled with water (blue).
- ▶ A tube runs right up the inside of the tube to a nozzle outside (gray).
- ▶ The nozzle often ends in a piece of bendy **plastic** so you can easily direct it toward the base of a fire.
- ▶ To operate the extinguisher, you pull the ring and press the handle.
- ▶ Pressing the handle opens a valve (shown here as a green arrow) that releases the pressurized gas from the canister.
- ▶ The gas immediately expands and fills the inside of the extinguisher, pushing the water downward
- ▶ As the water is pushed down, it rises up the tube
- ▶ A jet of water emerges from the nozzle.



# Powder type ( DCP ) Extinguisher

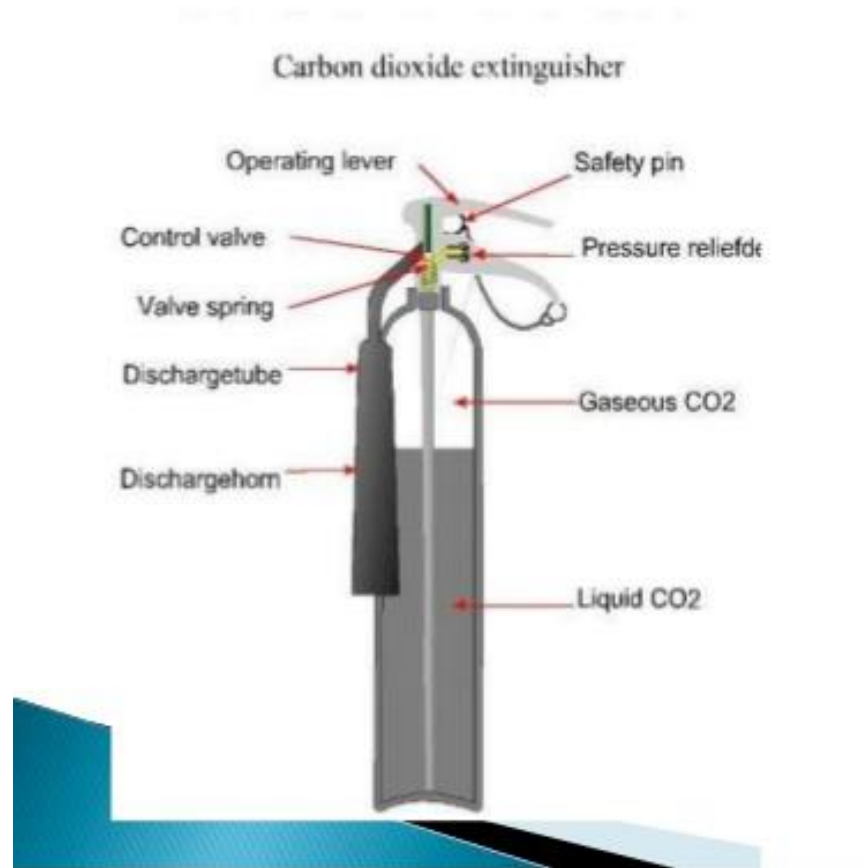


# Foam Extinguisher





# CO<sub>2</sub> Extinguisher





# CO<sub>2</sub> Extinguisher

- ▶ These consist basically of a pressure cylinder with a valve for releasing the gas and a discharge horn. The gas is maintained in liquid form at a pressure of 50 bars (750 psi).
- ▶ The discharge horn allows the gas to expand at a ratio of 450:1 and when it is directed into the fire, prevents air from being pulled along entrainment by reducing the velocity of gas.
- ▶ The average discharge time is 16 – 30 seconds.

## **Advantages:**

- ▶ i. Rapid in action, independent of atmospheric temperature.
- ▶ ii. It is an inert gas which quickly disperses, leaving no residue.
- ▶ iii. It is a non-conductor of electricity.
- ▶ iv. Can be used in the incipient (first) stage of high temperature liquid fires.
- ▶ v. Penetrates inaccessible places

## **Disadvantages:**

- ▶ i. The total weight in relation to the contents is considerable.
- ▶ ii. There is no visible way to check the contents.



# Usage of Extinguishers

Extinguisher	Type of Fire						
	Colour	Type	Solids (paper)	Flammable Liquids	Electrical Equipment	Cooking oils & Fats	Flammable Gas
		Water	✓	●	●	●	●
		Foam	✓	✓	●	✓	●
		Dry Powder	✓	✓	✓	●	✓
		Carbon Dioxide (Co2)	●	✓	✓	✓	●
		Blanket	✓	✓	✓	✓	✓

# What is PPE?

- ▶ Personal protective equipment (**PPE**)
- ▶ It is refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter.



# Safety Gadgets

## **CCTV Cameras :**

For surveillance of movement/footages of incidents and accidents



## **SMOKE DETECTOR :**

Is used to detect the smoke and alarm goes on





# Manual Call Point & Hooter



MCP



Hooter

# Safety Gadgets

## **FIRE ALARM PANEL BOARD :**

To monitor breakup of fire and know the exact location of fire





# Safety Gadgets

## Fire sprinkler system

A fire sprinkler system is an active fire protection measure, consisting of a water supply system, providing adequate pressure and flow rate to a water distribution piping system. A glass bulb type sprinkler head will spray water into the room if sufficient heat reaches the bulb and causes it to shatter. Sprinkler heads operate individually. Note the red liquid alcohol in the glass bulb.



# Safety Gadgets



Hydrant System



Hose Reel Drum

# Safety Gadgets



Hose Box



Single Hydrant



# Safety Gadgets

## FIRE HYDRANT SYSTEM :

To control major fire in coordination with the Engineering department.



# Safety Gadgets



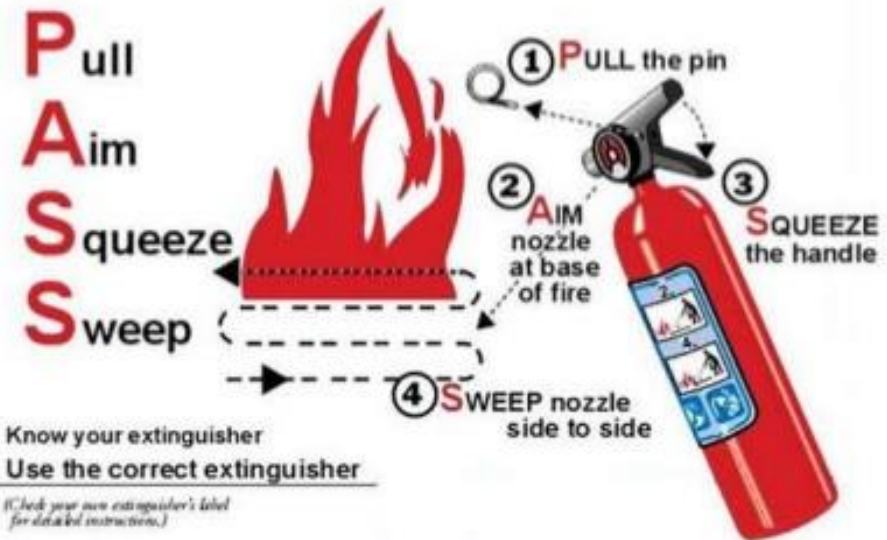
Smothering Method



Fire Blanket

# PASS Method of Fire Fighting

To operate an extinguisher:



# Fire Evacuation Plan

**Fire Evacuation Plan**

**1** Stop work immediately when you hear the fire alarm

**2** Follow your evacuation route & proceed to the designated assembly area

**3** Do not use elevators

**4** Use exit staircases

**Fire action**  
If you discover a fire

- Operate nearest fire alarm point.
- Call the Fire brigade by telephoning **112**
- Leave the building by the nearest exit.
- Report to your assembly point at
- Do not stop to collect personal belongings



# R-A-C-E

## Method of Fire response

How will you react in case of fire?



### R-A-C-E

- **R**escue
- **A**larm
- **C**onfine
- **E**xtinguish (If Trained) and Evacuate



## If **fire** occurred

### DO'S

- ❑ Stop the work and escape from the work place
- ❑ Assembly at fire assembly point.
- ❑ Call emergency number
- ❑ If small fire and if you are trained you can use fire extinguisher.



### DON'T'S

- ❑ Don't collect personal belongings
- ❑ Don't rush and panic
- ❑ Never use elevators/lifts under any circumstances.
- ❑ Don't hide



## **EVERY ONE MUST KNOW**

- **WHAT IS FIRE ?**
- **THE COMMON CAUSES OF FIRE,**
- **WHAT TO DO INCASE OF FIRE,**
- **HOW TO CALL FIRE BRIGADE,**
- **WHAT TO DO WHEN FIRE BRIGADE ARRIVES.**
- **THE NEAREST FIRE ALARM (IF PROVIDED),**
- **HOW TO OPERATE FIRE ALARM,**
- **THE NEAREST “MEANS OF ESCAPE”,**
- **THE NEAREST FIRE EXTINGUISHERS,**
- **HOW TO OPERATE AN EXTINGUISHER**

As a staff of the Hospital you have a responsibility for fire safety. Make sure you know

- ▶ What the fire alarm sound like in your building
- ▶ The Escape routes within your building
- ▶ If you discover a fire, how to raise the alarm
- ▶ What to do if you hear the fire alarm
- ▶ Who to call if a fire starts
- ▶ How to open fire exit doors
- ▶ Why is it important to go to the assembly area?
- ▶ Why fire doors should remain closed at all times?
- ▶ Why are fire extinguishers provided?

## On Your Return to Your Workplace Today

### **Ensure that you know;**

- ▶ The escape routes
- ▶ Emergency exit doors and how to open them
- ▶ Location and types of fire fighting equipment
- ▶ Locations of call points
- ▶ Any specific fire procedures including the assembly points
- ▶ Who are your Reporting authorities /Safety Managers.
- ▶ Whom to report to for any defects or bad practices.



## **FIRE** Simple Definition

- ▶ **F** – Find what type the fire is.
- ▶ **I** – Inform to everyone by raising alarm
- ▶ **R** – React Immediately, Restrict the fire by closing doors, Isolating the fuel electricity supply
- ▶ **E** – Extinguish the fire by using the correct type fire extinguish media



Thank

you

