Setrac College of Offshore Training

Fire Prevention & Fire Fighting

Trainee Handout

ISSUE DATE – Oct 2014		
DATE	REVISION	REVISED BY
01 Jan 2016	Rev 01	Training Coordinator
01 Jan 2020	Rev 02	Training Coordinator
01 Jan 2023	Rev 03	Training Coordinator
01 Jan 2024	Rev 04	Training Coordinator

COURSE TIME TABLE

Period	Day1	Day2	Day3
1 – 0830-1000	**Registration** **Introduction , Safety & Principles** **Theory of Fire (1H) -**Conditions for fires, Properties of flammable materials, Fire hazard and spread of fire	**PRACTICAL TRAINING AT FIRE FIGHTING MOCK-UP** **Fire-fighting Equipment** **Fire-fighting Drills** Small fires Extensive fires Drills in smoke-filled spaces ***PV, KP,KJ***	**Fire Fighting Equipment -**Fire hoses and nozzles, Mobile apparatus, Portable fire extinguishers , Fireman's outfit ; Breathing apparatus - Resuscitation apparatus Fire blankets
2- 1010-1140	**Theory of Fire (1H) -** Classification of fires and appropriate extinguishing agents **Movie (0.5H) -** **Fire Prevention-** Fire prevention principles		**Fire-fighting Methods** - Knowledge of fire safety arrangements, Fire alarms and first actions , Fire fighting
3- 1140-1240	**Fire Prevention-** Ship construction arrangements, Safe practices **Fire Detection Systems & Alarms –** Fire & Smoke Detection, Automatic Fire Alarm		**Ship Fire-fighting Organization-** General emergency alarm, Fire control plans and muster list, Communications, Personnel safety procedures, Periodic shipboard drills, Patrol systems
4- 1240-1340	**Fixed Fire-extinguishing Systems** -Smothering effect systems: carbon dioxide,(CO_2), foams , Inhibitor effect systems: powders , Cooling effect systems: sprinklers, pressure spray,		**Fire-fighting**
5- 1410-1510	**Fixed Fire-extinguishing Systems** - Emergency fire pump (cargo ships), 7.25Chemical		**Review & Assessment**

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Chapter 1

Introduction to Ship Fire Safety

Fire can be devastating on a ship - particularly on a passenger ship, where large numbers of people may need to be evacuated, or on a ship carrying inflammable cargo, with serious risks to crewmembers or to ports and harbours. On 1 July 2002, a comprehensive new set of requirements for fire protection, fire detection and fire extinction on board ships entered into force as a new revised Chapter II-2 of the International Convention for the Safety of Life at Sea (SOLAS), 1974, as amended, incorporating technological advances in fire detection and extinction as well as lessons learned from fire incidents over the years. The regulations are designed to ensure that fires are first of all prevented from occurring - for example by making sure that materials such as carpets and wall coverings are strictly controlled to reduce the fire risk; secondly, that any fires are rapidly detected; and thirdly; that any fire is contained and extinguished. Designing ships to ensure easy evacuation routes for crew and passengers are a key element of the chapter.

History of SOLAS fire protection requirements

1914 and 1929 SOLAS Conventions

The first fire protection requirements for international shipping were developed as part of the 1914 SOLAS Convention, which was developed in response to the sinking of the Titanic in 1912. Although the 1914 SOLAS Convention was prevented from coming into force due to World War I, it did contain basic fire safety requirements which were later carried over to the 1929 SOLAS Convention.

1948 and 1960 SOLAS Conventions

After the adoption of the 1929 SOLAS Convention, many lessons were learned about the safety of shipping in general, including fire protection, which led to the adoption of the 1948 SOLAS Convention. In 1934, a fire aboard the passenger ship Morro Castle caused 134 casualties. The investigation of the Morro Castle fire, and the lessons learned from it, played a major part in the development of the non-combustible construction regulations which today form the basis of the fire safety regulations for passengers ships. In addition, many advances in maritime technology were made during World War II and subsequently incorporated into the 1948 SOLAS Convention. As a result, a greater emphasis was placed on fire safety aboard ships and this was demonstrated by the development of three new parts (parts D, E and F) being added to chapter II of the 1948 SOLAS Convention which were exclusively dedicated to fire safety. In addition, the SOLAS 1948 requirements applied to both passenger ships and cargo ships.

The 1948 SOLAS Convention established three methods of construction for passenger ships and basic fire protection requirements for cargo ships. The 1948 SOLAS Convention was eventually updated with the 1960 SOLAS Convention. The most significant change incorporated into the 1960 SOLAS Convention, related to fire safety, was the application of certain passenger ship fire safety requirements to cargo ships

Fire and Flooding are the two potential hazards in ships. Fire fighting needs to be seen in broader sense in terms of fire, fire prevention, fire detection and fire fighting. *In order to successfully put out a fire, you need to use the most suitable type of extinguishing agent—one that will do the job in the least amount of time, cause the least amount of damage and result in the least danger to crew members. The job of picking the proper agent has been made easier by the classification of fire types, or classes, lettered A through D. Within each class are all fires involving materials with similar burning properties and requiring similar extinguishing agents. However, most fuels are found in combinations, and electrical fires always involve some solid fuel. Thus, for firefighting purposes, there are actually seven possible fire classes. Knowledge of these classes is essential to firefighting, as well as knowing the burning characteristics of materials found aboard vessels*

Important Termilogy

BOIL OVER: A phenomenon produced when water falls on oil that is at temperature close to or higher than the boiling temperature of water i.e. 100ºC water gets converted into steam and rises with particles of oil in the form of clouds which gets ignited instantaneously in dangerous manner. Such an occurrence can spread the fire and cause injury to the personnel nearby.

SPOTANEOUS COMBUSTION: The ignition of material brought about by a heat producing (EXOTHERMIC) chemical reaction within the material itself without exposure to an external source of ignition.

LOWER FLAMMABLE LIMIT (LFL): Minimum concentration of Hydrocarbon gas (% by volume) in air to support and propagate combination. It is also referred as Lower Explosive Limit.

UPPER FLAMMABLE LIMIT (UFL): The maximum concentration of Hydrocarbon gas (% by volume) in air above which explosion does not occur.

FLAMMABLE / EXPLOSIVE RANGE: The range of combustible vapours or gas in air within which the vapour and air mixtures is flammable between the UFL and LFL that allows a fire or an explosion to take place.

STATIC ELECTRICITY: The electricity produced on dissimilar material through physical contact and separation.

INERT CONDITION: A condition in which oxygen contained through out the atmosphere of a tank has been reduced to 8% or less by volume by addition of inert gas.

GAS FREE: A tank, compartment or a container is gas free when sufficient air has been introduced in to it to lower the level of any flammable / toxic gases or inert gases to those required for a specific purpose e.g. Hot work, entry etc.

FLAMMABILITY: It is the ability of substance to burn. Vapors given off by a flammable material can burn when mixed with air in the right proportion, in the presence of an ignition source.

FOAM (also referred as "Froth"): An aggregation of bubbles having coherent relation and specific lower gravity than any lightest fuel formed by soapy water is known as Foam.

THRESHOLD LIMIT (TLV): The time-weighted average concentration of a substance to which nearly all workers may be repeatedly exposed for a normal 8 hours working day or 40 working weeks, day after day, without adverse effect.

FLASH POINT: The lowest temperature at which a liquid gives of sufficient gas vapours to form a flammable gas mixture near the surface of the liquid which will flash momentarily when flame is applied, e.g., oils with flashpoints below 23ºC are classified as dangerous highly inflammable, such oils are gasoline, benzenes, etc.

IGNITION POINT / FIRE POINT: This is the temperature at which the volatile vapours given off from a heated oil sample are ignitable by flame application and will burn continuously. The fire point temperature can be anything up to about 40ºC higher than the closed flashpoints temperature for most fuel oils.

AUTO-IGNITION: It is the ignition of a combustible material without initiation by spark or flame when the material has been raised to a temperature at which self-sustaining combustion occur. (Exothermic Chemical Reaction).

BURNING SPEED: Burning Speed or Flame Speed is the speed of rapid propagation of the flame from flammable vapour and air mixture. When flammable vapour and oxygen are present in the right quantity required to oxidize it completely, then the mixture is said to be stochiometric and any ignition will produce the most rapid propagation of flame.

HOT WORK: It is the work involving sources of ignition or temperature sufficiently high to cause ignition of a flammable gas mixture. This includes any work requiring the use of welding, burning or soldering equipment, blow torches, some power driven tools, portable electrical equipment's which is not essentially safe or contain with in an approved explosion proof housing, sand blasting equipment and internal combustion engine.

WATER FOG: A suspension in the atmosphere of very fine droplets of water usually delivered at high pressure through a fog nozzle to use in the fire fighting.

WATER SPRAY: A suspension in the atmosphere of water divided into coarse drops by delivery through a special nozzle for use in fire fighting.

HALON: A halogenated hydrocarbon used in fire fighting, which inhibits flame propagation.

DRY CHEMICAL POWDER: A flame inhibits powder used in fire fighting.

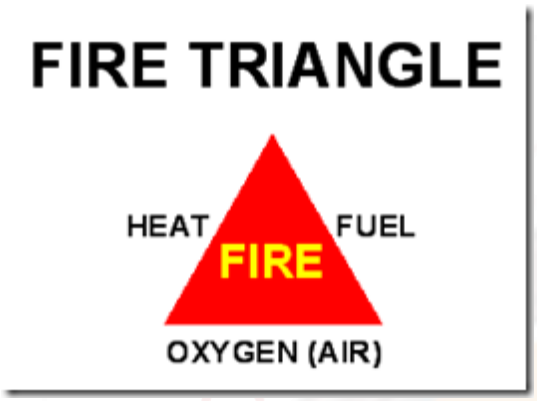
RESUSCITATOR: Equipment to assist or restore the breathing of a man caused by gas or lack of oxygen.

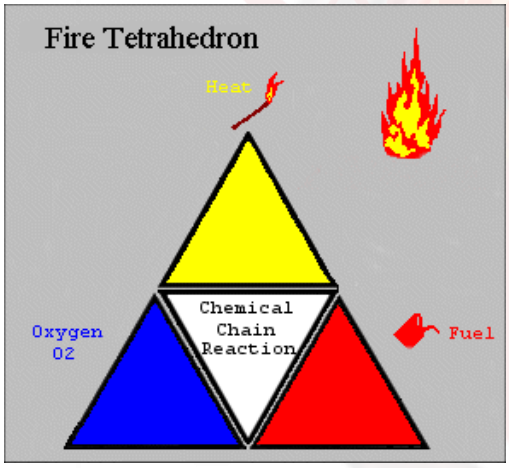
Chapter 2

Theory of Fire

Fire is the result of a chemical reaction of combustible substances with oxygen in presence of heat, which further produces heat, smokes, flame and light. For a fire to take place certain conditions must be met which are illustrated through a triangle or a tetrahedran which we will learn about later.

Controlled fire is used in our day to day lives for useful purposes. Only uncontrolled fire is dangerous which can cause damage to ship's crew and ship. A combination of three elements (air, fuel and heat) causes fire to take place. This can be easily understood by looking at the Fire Triangle.If any one of the element is isolated, then fire cannot take place. Fire is classified depending on the fuel that causes fire. *You may* remember the fire triangle which is composed of heat, fuel and air. These three things are needed to make a fire, remove any one of them and the fire is extinguished.





To move into a slightly more advanced theory of fires, there is a fourth ingredient necessary for fire, and the "fire tetrahedron" more accurately demonstrates the combustion process. A tetrahedron is a solid figure with four triangular faces. It contains the four things required for combustion; fuel (to vaporize and burn), oxygen (to combine with the fuel vapor), heat (to raise the vapor to its ignition point) and the chain reaction (the chemical reaction among the fuel, oxygen and heat). Remove any of these four and you have no fire.

Class A Fires—Fires of common combustible solids such as wood, paper and plastic are best put out by water, a cooling agent. Foam and certain dry chemicals, which act mainly as smothering or chain-breaking agents, may also be used.

Class B Fires—Fires caused by flammable liquids such as oil, grease, gas and other substances give off large amounts of flammable vapors and require smothering agents to do the job. Dry chemical, foam and carbon dioxide (CO2) may be used. However, if the fire is being supplied with fuel by an open valve or broken fuel line, you must first shut down the source of the fuel. This action alone may stop the fire or at least make it easier to put out. In a gas fire, it is important to shut down the source of the fuel. Attempting to put out the fire without shutting down the sources, creates an explosive hazard that is more dangerous than the fire itself. If may be necessary to put out a gas fire before shutting down the fuel supply in order to save a life or reach the supply valve, but these should be the only exceptions.

Combination Class A and B Fires—Water fog and foam may be used to smother fires involving both solid fuels and flammable liquids or gases. These agents also have some cooling effect on the

fire. In enclosed spaces, CO2 may also be used. Caution: CO2 robs the air of oxygen and can suffocate a person using CO2 to put out the fire in enclosed spaces.

Class C Fires—For fires involving energized electrical equipment, conductors or appliances, non-conducting extinguishing agents must be used such as CO2, Halon and dry chemical. Note that dry chemical may ruin electronic equipment. Always attempt to remove the source of electricity to remove the chance of shock and the source of the ignition.

Combination Class A and C Fires—Since energized electrical equipment is involved in these fires, non-conducting agents must be used. CO2, Halon, and dry chemicals are best. CO2 reduces the oxygen supply, while the others break the chain reaction. REMEMBER: Always try to de-energize the circuit.

Combination Class B and C Fires—Again, a non-conducting agent is required. Fires involving flammable liquids or gases and electrical equipment may be extinguished with Halon or dry chemical acting as a chain reaction breaker. In enclosed spaces, they may be extinguished with CO2.

Combination Class D Fires—These fires may involve combustible metals such as potassium, sodium, and their alloys, and magnesium, zinc, zirconium, titanium and aluminum. They burn on the metal surface at very high temperature, often with a brilliant flame.

Water should not be used on Class D fires. It may add to the intensity and cause the molten metal to splatter. This, in turn, can extend the fire and inflict serious burns on those near by. Combustible metal fires can be smothered and controlled with special agents known as dry powders. Although many people use the term interchangeably with dry chemicals, the agents are used on entirely different types of fires: dry powders are used only to put out combustible metal fires; dry chemicals may be used on other fires, but not on Class D fires.

Chapter 3

Sources of ignition & Preventive measures

Spontaneous combustion

Dirty waste, rags, sawdust and other rubbish - especially if contaminated with oil - may generate heat spontaneously which may be sufficient to ignite flammable mixtures or may set the rubbish itself on fire. Such waste and rubbish should therefore be properly stored until it can be safely disposed of. Materials in ship's stores, including linen, blankets and similar absorbent materials are also liable to ignite by spontaneous combustion if damp or contaminated by oil. Strict vigilance, careful stowage and suitable ventilation are necessary to guard against such a possibility. If such materials become damp, they should be dried before being stowed away. If oil has soaked into them, they should be cleaned and dried, or destroyed. They should not be stowed in close proximity to oil or paints, or on or near to steam pipes.

Machinery spaces

All personnel should be made fully aware of the precautions necessary to prevent fire in machinery spaces - in particular, the maintenance of clean conditions, the prevention of oil leakage and the removal of all combustible materials from vulnerable positions. Suitable metal containers should be provided for the storage of cotton waste, cleaning rags or similar materials after use. Such containers should be emptied at frequent intervals and the contents safely disposed of. Wood, paints, spirits and tins of oil should not be kept in boiler rooms or machinery spaces including steering gear compartments. All electric wiring should be well maintained and kept clean and dry. The rated load capacity of the wires and fuses should never be exceeded.

Galleys

Galleys and pantries present particular fire risks . Care should be taken in particular to avoid overheating or spilling fat or oil and to ensure that burners or heating plates are shut off when cooking is finished. Extractor flues and ranges etc should always be kept clean. Means to smother fat or cooking oil fires, such as a fire blanket, should be readily available close to stoves. Remote cut-offs and stops should be conspicuously marked and known to galley staff

Chapter 4

Fire Prevention

If total awareness is created to all personnel on Fire Prevention, then there is no need for Fire Detection, Fire Fighting etc. Remember the old saying " Prevention is better than Cure"

Prevention of Class A(General) Fire is by:

- good house Keeping
- taking regular rounds of working premises
- use of fire retardant, fire resistant materials while construction of ships wherever applicable
- keeping working areas under lock & key, when not in use or manned
- denying entry to unauthorized personnel

Prevention of Class B (Oil) Fire is by:

- Proper storage of oil & petro products
- Properly maintained fuel handling systems
- Properly trained personnel
- Avoiding leakage in the fuel system
- No smoking
- Not using naked lights
- operating fuel systems under supervision

Prevention of Class C (Electrical) Fire is by:

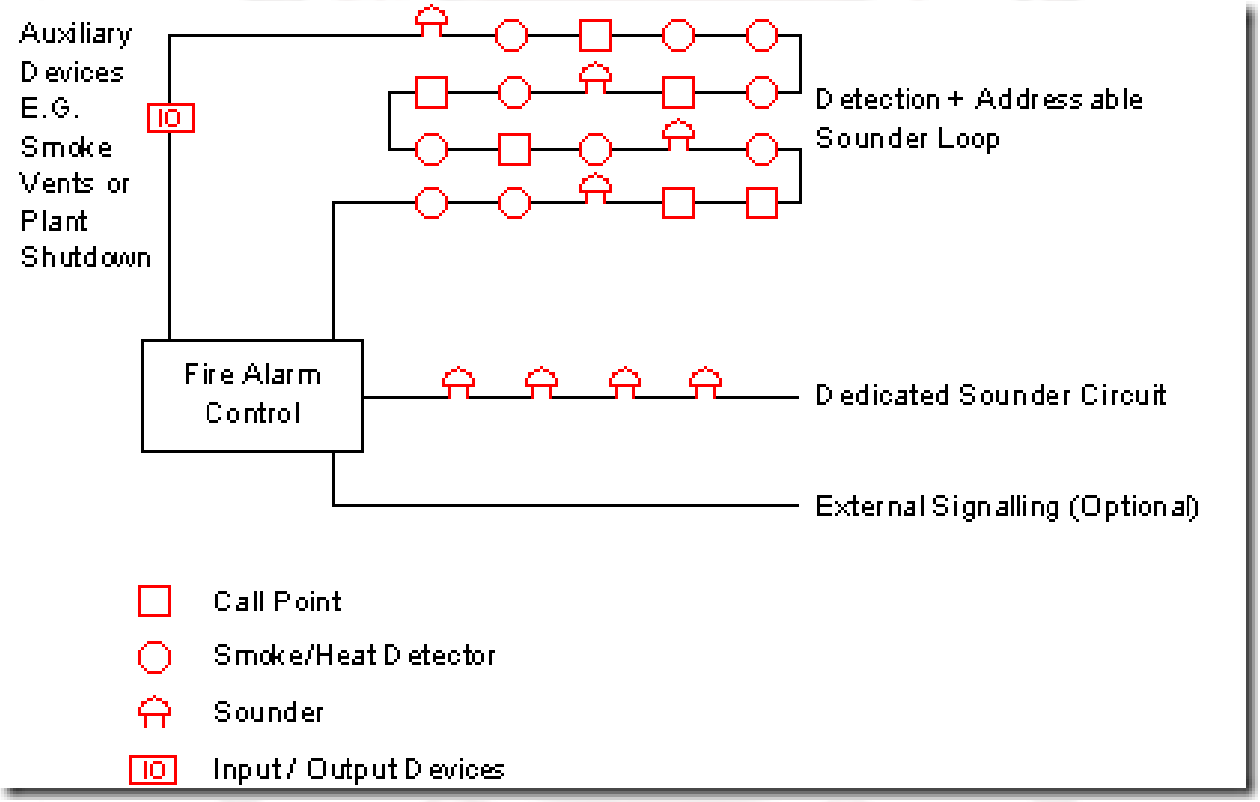
- Properly maintained Electrical equipment
- Ensuring proper electrical insulation
- Avoiding naked wires
- Using weather proof, explosion proof fittings where necessary
- Properly trained personnel
- Switching off electrical equipments when not in use (lights, fans, air conditioners etc.,)
- Avoiding prolonged use or overloading of equipment

Prevention of Class D (Chemical) Fire is by:

- Understanding the characteristics of the chemicals and accordingly standard operating procedures must be implemented for the personnel handling these chemicals
- Fire Detection:
- Manual detection
- Automatic detection (conventional or analog addressable)
- Manual detection is by:
- regular rounds by duty personnel during working and non working hours
- alert and competent ships crew
- observing the running machinery for abnormal noise, abnormal vibration, abnormal working temperatures etc.,
- CCTV – central monitoring through Closed Circuit TV
- Automatic detection is by electrical Fire Alarm Control Panel consisting of:
- Smoke Detectors placed in different parts of ship

- Heat Detectors placed in different parts of ship

Fig : A typical Analogue Addressable Fire Alarm Arrangement:



Safety precautions

Fire aboard a general cargo vessel can be disastrous. Common causes are:

i) faulty electrical appliances/circuitry
ii) overloading of electrical circuitry
iii) careless disposal of cigarette ends
iv) spontaneous combustion of dirty waste/ rags especially if contaminated with oil
v) damp storage of linen/materials
vi) oil spillage/leakage in machinery spaces
vii) galley fires due to overheating of cooking oils
viii) carelessness with hand pressing irons

ix) incorrect methods of drying laundry

The prevention of fire on board ship is of utmost importance. Below is outlined all probable sources of ignition and how to take preventive measures.

Smoking Conspicuous warning notices should be displayed in any part of the ship where smoking is forbidden (permanently or temporarily) and observance of them should be strictly enforced. Ashtrays or other suitable containers should be provided and used at places where smoking is authorised.

Electrical and other fittings

All electrical appliances should be firmly secured and served by permanent connections whenever possible. Flexible leads should be as short as practicable and so arranged as to prevent their being chafed or cut in service.Makeshift plugs, sockets and fuses should not be used. Circuits should not be overloaded since this causes the wires to overheat, destroying insulation and thus resulting in a possible short-circuit which could start a fire. Notices should be displayed warning that approval should be obtained from a esponsible officer to connect any personal electrical appliances to the ship's supply. All portable electrical appliances, lights etc should have insulation readings taken before use, and should be isolated from the mains after use. Electrical equipment which is to be used in any cargo area should be of an approved design.

It is important that all fixed electric heaters are fitted with suitable guards securely attached to the heater and that the guards are maintained in position at all times. Drying clothing on or above the heaters should not be permitted and suitably designed equipment should be supplied, or areas designated. When using drying cabinets or similar appliances, the ventilation apertures should not be obscured by overfilling of the drying space. Any screens or fine mesh covers around the ventilation apertures should be regularly inspected and cleaned, so that they do not become blocked by accumulated fluff from clothing.

The use of portable heaters should be avoided wherever possible. However, if they are required while the ship is in port (as temporary heating during repairs and as additional heating during inclement weather), a protective sheet of a non-combustible material should be provided to stand them on to protect wooden floors or bulkheads, carpets or linoleum. Portable heaters should be provided with suitable guards and should not be positioned close to furniture or other fittings. These heaters should never be used for drying clothes etc.

Personal portable space-heating appliances of any sort should not be used at sea and notices to this effect should be displayed. The construction and installation of electric heaters should always be carried out in accordance with the relevant regulations and instructions or guidance supplied by the manufacturer.

Chapter 5

FIRE DETECTION

The concept of preventing outbreak of fire or reducing the risk of spreading and avoiding the danger from fire to personnel and property is termed as fire prevention. The ultimate aim is to prevent the outbreak of fire. It must be however realized that perfectness is unlikely to be achieved due to either engineering compromise or human error. For example, electrical faults, which could give risk of fire cannot be totally eliminated but can be minimized by good design, construction and installation. Protective measures are included in the ships design such as segregation of accommodation space from cargo space. With this provisions it is important that fire detection is achieved so that the crew has a reasonable chance of extinguishing the fire. Marine fire prevention consists of a combination of active and passive defense, which forms integrated systems. Some common preventive measures are as listed below:

a) All machinery space to be kept clean.

b) Any fuel or oil leak must be attended to immediately.

c) Remote control of various machinery, blowers and fuel quick closing valves must be available a operational.

d) It should be possible to operate a fire pump / bilge pump from outside the machinery spaces.

e) Regular patrol should be undertaken in the accommodation spaces.

f) Stores such as paints and mineral oils must be kept out of accommodation spaces in specifically provided lockers.

g) Galley appliances must be switched off when not in use.

h) Special care must be taken when repairs are undertaken to ensure that fire fighting equipments to be made available.

The above list is by no means exhaustive and general awareness must be created to prevent any outbreak of fire on board a ship.Fire detector is device, which actuate on one scientific principle or another to give early warning of any assurance of fire. The detector operates in presence of a fire by reaching to one or more of the three characteristics of fire. i.e. smoke, heat & flame. There are three types of detectors, which are as follows: -

1) Smoke (combustion products) type

2) Flame (Radiation) type

3) Heat type

SMOKE DETECTORS

Smoke is a complex thing to describe because it varies considerably with materials that are burning. Basically it is composed of small particles suspended in air. And these particles have to be detected by smoke detector. Smoke may consist of gases and water vapour. Smoke detectors are of two types: IONISATION , OPTICAL

IONISATION DETECTOR: It is more sensitive to the smaller particles of smoke. In fact it is most sensitive to the invisible products of combustion that are given off in the early stage of fire which are given off by a clean burning of fire. The heart of this detector is an Ionization chamber in which a radioactive source acts on the atoms of air in the chamber to produce positive or negative ions. Two plates, which are positively or negatively charged, are contained in the chambers. Ions are attracted to plates of positive polarity thereby causing small electric current flows in the external circuit. When smoke particles enter the chamber they become attracted to the ions causing the movement of ions between plates. This results in reduction in current flowing in the external circuit, which is used to initiate an alarm.

OPTICAL DETECTOR: It becomes more sensitive as fire ages and suspend particles grow larger and visible which can be seen by naked eyes. Optical detector would be effective in the early detection of a PVC or rubber fire, which produces dense cloud of smoke immediately. These are further classified as LIGHT OBSERVATION TYPE & LIGHT SCATER TYPE. In **observation type**, a parallel beam of light is directed on to a photoelectric cell so that a current flows all the times. When smoke particles are introduced some of the light is reflected away from the photo cell causing reduced flow of current, which results in activation of alarm.In **light scatter** system; the light source is situated from a photocell so that no current flows in a non-fire condition. When smoke reaches to chamber light is scattered on the photoelectric cell, which then generates the electric current to initiate the alarm.

FLAME DETECTORS:

Most common type of radiation type is the infra red type. It is the special device sensitive to radiation from flame. Only and not the radiation's from other harmless sources. Such as sunlight, bulb and electric sparks. This type of detector is very effective. It does not depend upon smoke or heat from the fire.Ultraviolet detector is used where the maximum reliability and rapid response of flame is required. It is fitted in all craft hangers explosive and other flammable goods.Ultra violates detectors compresses two electrode across which a high voltage is applied. The electrodes are enclosed in a glass envelope, which will pass ultra-violet radiation, and the envelope is filled with an ionized gas.

HEAT DETECTOR

The most obvious effect of the fire is heat, but it is the last effect to make its present felt. Besides causing a rise in temperature, effects of heat are recognized in other ways, which are used in different types of heat detectors.

There are two types:

a) Fixed temperature
b) Rate of rise

Chapter 6

INTRODUCTION TO FIRE FIGHTING

METHODS OF EXTINGUISHING FIRE

a) Starvation: Removing or limiting fuel
b) Smothering: Removing or limiting oxygen (air)
c) Cooling: Limiting or decreasing heat / temperature
d) Inhibitation: Stopping / breaking chemical reaction which is building up heat and rise in temperature (exothermic reaction).

STARVATION Extinction of fire by starvation is removing the fuel / combustible material from the place of fire. This can be achieved by draining of fuel from tank, stopping fuel pumps, closing fuel valve or remote control valve.

SMOTHERING By cutting off the air (which contains oxygen) to the place of fire. This can be achieved by stopping the blower or closing the doors / hatch / porthole and closing the inlet and exhaust air trunking flaps. Fire can be smothered by a rug or a wet blanket. A small metal fire can be fought by sand. For liquid fuel fires, smothering is done by the use of foam. Foam forms a coating on liquid fuel surface and cuts off air. It also does not allow the liquid fuel to form a flammable vapor. It can also be done by forming a cloud of dry chemical powder (Sodium Bicarbonate) from a pressurized container. Powder also has cooling effect and can stop heat produced in the chemical reactions (exothermic i.e., more and more self-producing heat in a chemical reaction). For fuel cargo tanks, inert gas is used as smothering agent.

COOLING If heat can be taken away faster than the heat being produced due to fire, fire will be extinguished by a jet or spray of water to extinguish the fire is normally the best way.

FIRE EXTINGUISHING AGENTS

The most commonly used fire-extinguishing agents are as follows:

1. Water used, as cooling agents.
2. Foam of various types such as high, medium and low expansion types used as cooling and smothering agent.
3. Dry chemical powder used as inhibitor.
4. Carbon dioxide gas, sand, blanketing used as smothering agent, to cover fire with wet blankets is most commonly used for class ‘A’ fires.

USE OF WATER

It has got some advantages and disadvantages as given below:

Advantages

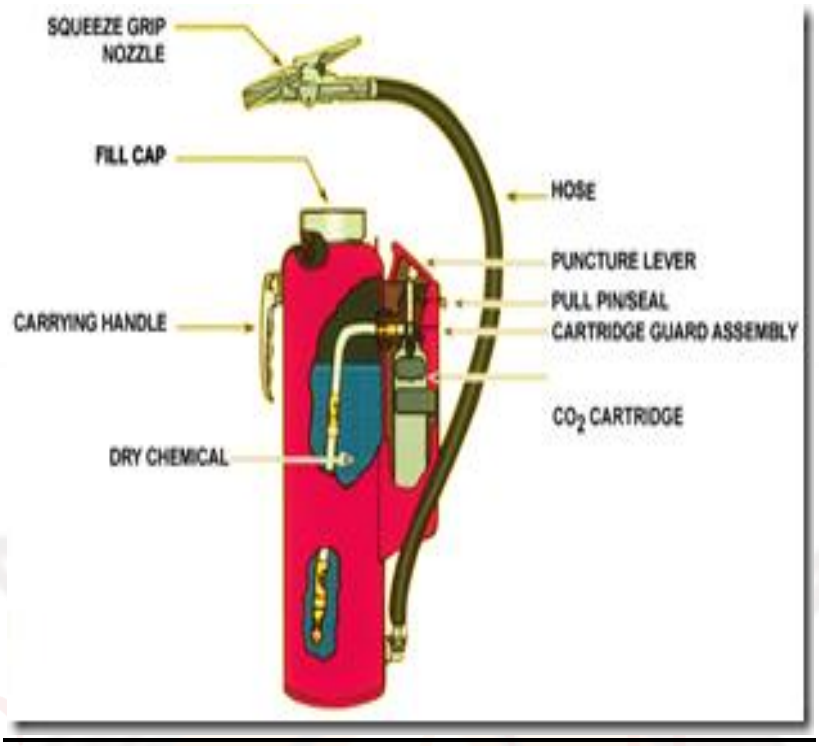
1. Best cooling media
2. Easily available
3. Cheap in cost
4. Water used in the form of steam i.e. best smothering agent

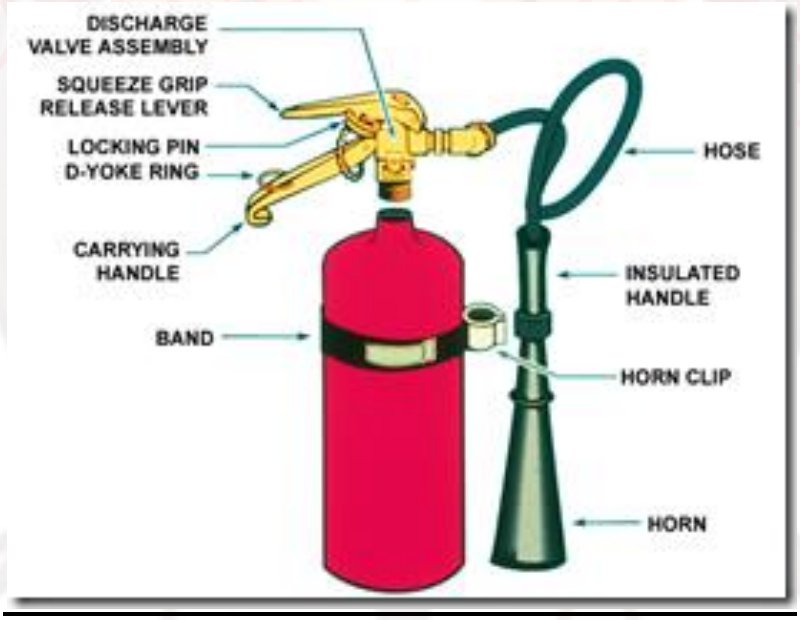
Disadvantages

1. Good conductor of electricity
2. It effects the stability of the ship when used in large quantity
3. It damages cargo, machinery, electric equipment etc.
4. It has the boil over effect causing excessive burning effect on fire fighters.

Fire Extinguishing Agents

Agent	Advantages	Disadvantages
Water	• Always Available • Excellent cooling properties • Provides protection for fire party • Best choice for Class A	• Not to be used on Electrical Fires • Can reduce stability • Can spread Class B fires • Damages/destroys equipment
Foam	• Forms air-tight blanket over burning liquids • Minimal chance of re-flash • Can be used from distance-around corners, from upper decks	• Not to be used on Electrical Fires • Damages/destroys equipment
Dry-Chemical	• Knocks down flames • Fast and effective • 15' range • Rated for Class B and C fires	• Minimal Protection against re-flash • Highly corrosive to electronic equip. • Agent can cake and solidify in container
Carbon Dioxide	• Safe for Class C • Non-corrosive, non damaging to equip. • Minimal chance of re-flash in sealed space • Effective on small Class A & B fires in open spaces	• Displaces oxygen - can kill firefighters • No re-flash protection in open spaces
Halon	• Safe for Class C • Non-corrosive, non damaging to equip. • Minimal chance of re-flash in sealed space • Effective on small Class A & B fires in open spaces	• No re-flash protection in open spaces • In very hot fires, can generate deadly phosgene gas • No longer available after 2000 AD


SQUEEZE GRIP
NOZZLE
FILL CAP
HOSE
PUNCTURE LEVER
PULL PIN/SEAL
CARRYING HANDLE
CARTRIDGE GUARD ASSEMBLY
CO_2 CARTRIDGE
DRY CHEMICAL


DISCHARGE
VALVE ASSEMBLY
SQUEEZE GRIP
RELEASE LEVER
LOCKING PIN
D-YOKE RING
HOSE
CARRYING
HANDLE
INSULATED
HANDLE
BAND
HORN CLIP
HORN

Chapter 7

FIXED FIRE-FIGHTING INSTALLATIONS

When vessels in the past caught fire while at sea, they usually tried to fight the fire by conventional means. Obviously each case must be treated in the light of the circumstances prevailing at the time, with due consideration being given to the facilities available. In the author's view attempts should be made in the case of engine room fires to bring them under control before the injection of a fire-fighting gas medium, for the following reasons:

1. Injection of, say,CO2 gas would immobilise the machinery space and virtually leave the vessel without motive power and at the mercy of the weather.

2. Once injection has taken place, it is unlikely that a second supply of gas could be made available. Therefore, as there is only one chance in most cases for the gas to take effect, this chance should not be wasted in the early stages. This is not to say that there should be any hesitation once it has been decided to use gas. Then speedy injection could be to the benefit of all. Conventional fire-fighting methods in the way of hose/branch lines and foam installations within the machinery space may be the ideal firefighting medium. Breathing apparatus will be needed, so that a plentiful supply of 'full air bottles' will be required; failing this, means of refilling (compressor) air bottles, located outside the machinery space, should be provided. In several cases valuable time has been bought by fighting a fire by conventional means until the air bottles for the self-contained breathing apparatus have run out.Time won in this way can be usefully employed in seeking out a safe anchorage or port having good fire-fighting facilities or clearing away survival craft. Cargo hold and tank space fires may, by their very nature, have to be treated as completely different sorts of fire. Relevant facts as to the available access to the fire area have to be considered, and flooding of a fire area may also be a worthwhile proposition, having due regard to the stability and free surface effects.

Steam Smothering Systems

In general the Administration does not permit the use of steam as a fire extinguishing medium in fixed fire extinguishing systems. However, where the use of steam is permitted, it should be used only in restricted areas as an addition to the required fire-fighting medium. The boilers supplying such steam will have an evaporation of at least 0.1 kg of steam per hour for each 0.75m3 of the gross volume of the largest space to be protected. In complying with these requirements the system shall be determined by and to the satisfaction of the Administration.

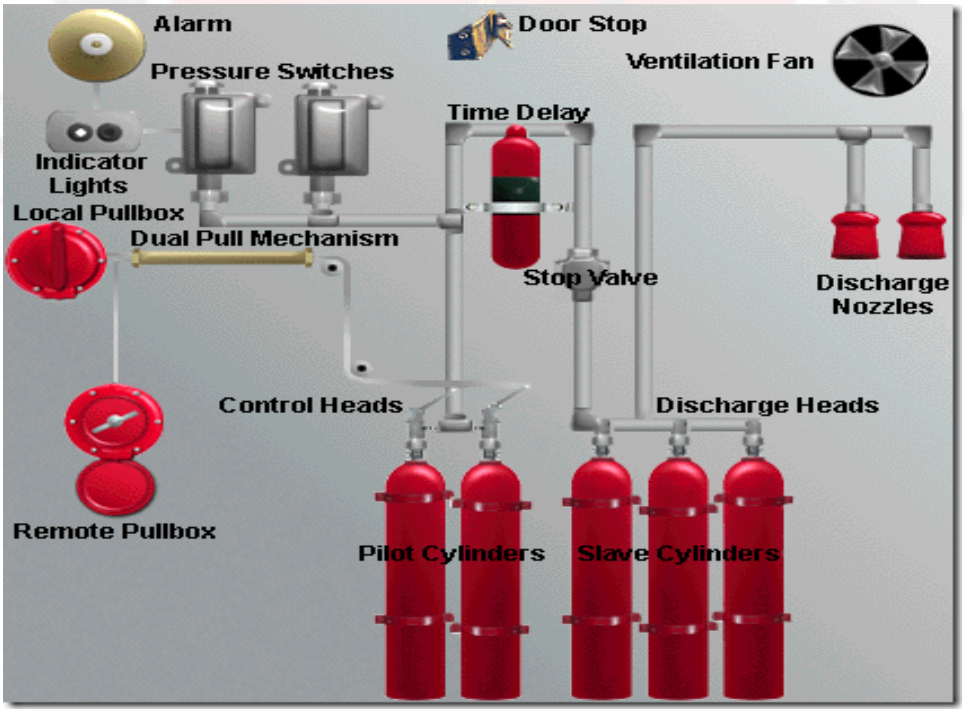
***Carbon Dioxide* (CO2)**

This is probably the most popular of all the fixed fire-fighting systems employed at sea.The normal design incorporates a fixed bank of CO2 container bottles whose contents can be directed, automatically or by direct

manual operation, into any of the ship's protected spaces . Many systems are used in conjunction with a smoke detector unit, 10 tonnes of liquefied CO2, is mounted on supporting stools, insulated by 150

mm of fire-resistant polyurethane foam, and finished in 1 mm galvanised steel plates. Refrigeration units may be attached to the tank or sited separately, giving the CO2 a normal temperature of _20°C. Two independent units are the norm, working automatically, each being cooled by sea water and operated from external control panels.Alarm systems for each tank cover compressor failure, high pressure inside tank, low level in the tank and leakage through safety valves. the same sampling pipes guarding against smoke being used to inject the CO2 gas via a three-way valve. Fire-fighters should be aware that CO2 is a smothering agent rather than an actual extinguishing one.The purpose of the gas is to deprive the fire of oxygen and by so doing break the fire triangle. Carbon dioxide is heavier than air and is usually injected into the upper levels of cargo holds and machinery spaces, all the oxygen being pushed to the upper levels as the CO2 settles at the bottom of the space. CO2 gas has the following characteristics:

1. It is a non-flammable gas.
2. It is colourless.
3. It is odourless.
4. It is readily available in almost every port of the world.
5. It is comparatively cheap.
6. Systems may incorporate smoke detector units.
7. It may be kept either in 45 kg cylinders or in bulk storage tanks.
8. Normal temperature of liquefied CO2 is _20°C.



FIRE ALARMS:

a) An automatic fire alarm and detection system fitted on board ships, gives fire alarm on bridge and in engine room /control room on sensing fire. The object of fitting fire detectors is to minimize the effects of unwanted fires by sounding alarm, to alert ship's personnel, before the fire has a chance to grow too large or spread too far. They are fitted in accommodation and machinery spaces.

b) Automatic fire detectors operate on various principles. The type that are provided on board ships are generally the one which is stated above.

FIRE ALARM SYSTEMS:

A fire alarm system is designed to give an early warning in case of smoke and fire in building site / ship so that one can extinguish the fire immediately, protect persons and property, records, costly equipment's etc. from being destroyed. It is usually powered with the single-phase AC mains with battery backup up to 48 hrs, and it needed DG backup. Thus being safe (fool proof) for irregular power supply, also cross zoning is eliminated with the help of addressable detectors (a special type of detector in which a 4 bit code is given one for its zone. Third and fourth for the Serial number of detector in that particular circuit) and placing the two detectors in series e.g. the heat sensitive one and the rate of heat rise type. The other major advantage of fire alarm system is its synchronization with real time to record the zone, time, place of the affected area can be printed immediately or logged on an hourly basis thus ensuring proper functioning of the system and is usually coupled to PAS (PUBLIC ADDRESS SYSTEM) for aural message communications. There are two types of fire alarm systems viz, Manual & Automatic. The most common is being automatic type. The main components of fire alarm systems are as follows:

1. Main control panel, usually a separate card (PCB) for each zone.
2. Repeater panel usually in the Main Security Room.
3. Open solenoid valve of a canisters or other extinguishers / sprayers.
4. Manual call stations call select place.

5. Heat sensitive detectors rate of heat rise type or combined.
6. Smoke detectors either optical or ionization type.
7. Hooter / siren
8. Computer
9. Telephone call to residence of higher authorities, nearest fire stations.

Chapter 8

Fighting Accommodation, Galley & Machinery Space Fires

ACCOMMODATION FIRES AT SEA

Generally all major fires originate from either a smaller fire or an explosion. It is unlikely that fires within the accommodation will be caused by an explosion; consequently, speedy and efficient action to deal with the smaller fire will often prevent the larger, more crippling fire developing. Regular training drills,well planned and using all the ship's equipment, are not only reassuring to passengers and crew members but an efficient method of making personnel familiar with the equipment available. Even if a fire is only suspected, the alarm should be raised immediately and crew members should be in no doubt that a false alarm would not result in punishment. Accommodation fires generally occur in Class 'A' combustible material (see Table 15.1); bearing this in mind, the following course of action is recommended :

1. Raise the alarm.

2. Reduce speed. (all types of fire)

3. Close down all mechanical ventilation.

4. Have fire-fighters,working in pairs, investigate and tackle the fire.

5. Isolate electrical 'live' circuits.

6. Surround the fire,attacking it from as many sides as possible with hoses.

7. Close all fire and watertight doors.

8. Approach the fire with the aid of breathing apparatus.

9. Have communications officer standing by to transmit emergency or distress signals.

10. If traffic,weather and sea room will allow bring the wind to a direction that will reduce the draught in the ship.

The order of events will, without doubt, vary with circumstances, and the actions of individuals will be dependent on the location of the fire and the facilities available in the vicinity.The above-mentioned procedure may be elaborated on. *Reduction of speed* is necessary because the speed of the vessel through the water will provide continuous draught for the fire. This will provide oxygen for the fire, not the required starvation.

Closing down all mechanical ventilation will help to stop the passage of heat and smoke throughout the ship. Should heat or smoke be drawn in through passages etc. it may become necessary to evacuate adjoining compartments. gain starvation of the oxygen supply, effectively reducing the spread of heat, smoke and the fire itself, will not be accomplished.

Fire-fighters need to operate in teams of not less than two men because the average person's courage in the face of danger is reduced considerably if he is alone.Two or more men may also be necessary to achieve a success, or at least better efficiency than one.

Isolation of 'live circuits' is necessary because the dangers of water as an electrical conductor are well known, particularly when a strong jet of water is being brought into operation. Isolation of live circuits must be carried out before the fire is attacked with any water branch line, whether operating on jet or spray.

Surrounding the fire and attacking it, rather than operating from one side only, stops the fire being pushed from one region to another. It should not be forgotten that any fire has no less than six sides, and all six sides should be attacked whenever possible.This may only be in the form of boundary cooling of bulkheads, but the heat content and its effect are reduced.

Watertight and fire doors must be closed for any emergency when the hull is threatened. Not only is the passage of heat and smoke restricted but subsequent casualties caused by the passage of fire or explosion can be greatly reduced.This is especially important on passenger vessels. *Breathing apparatus* is essential for tackling accommodation fires, especially if internal fittings such as furniture containing polyurethane foam are present.Toxic fumes from burning upholstery can be extremely hazardous for fire-fighters.Smoke helmets, for this reason, should not be worn, only the self-contained breathing apparatus.

Tackling the fire speedily is essential. Unless early location of the fire is made, fire-fighting may become extremely difficult. Rows of cabins and passageways tend to transmit heat and smoke quickly over a considerable area. Many of the cabins may form smoke traps, disguising the location of the fire to the fire-fighter or rescuer. Initial actions are important, and these will depend on location and type of fire. If it is in a cabin, considerable build-up of heat may have already taken place, and entry could be disastrous if the interior has not been cooled off. This can usually be achieved by breaking open the bottom panel of the door and directing a jet to the deck head.This action will cause a deflection of the water jet and cool the interior of the cabin down, prior to entry by fire fighters behind a protective spray curtain. Indiscriminate smashing of ports and doors, however, should be avoided unless necessary to save life.

GALLEY FIRES AT SEA

The successful extinguishing of a galley fire will be more readily achieved if the location and method of using the available extinguishing agents are known before hand. Freedom of access to these extinguishing agents is essential, and they should at no time be used for any other purpose than that for which they are designed. A ship's galley will normally be equipped with several or all of the following extinguishing agents;

1. Foam extinguishers for oil-fired stoves

2. Dry powder extinguishers for electric stoves.

3. CO2 extinguishers.

4. Fire blanket.

5. Sand and scoop in buckets or containers.

6. Small hose reel and nozzle.

7. Fire box, close to hand, containing hose, spray/jet nozzle, and fire axe.

Speedy and correct use of the above could reduce the risk of a major fire.Lack of thought in tackling the common chip pan fire could result in the whole of the galley area becoming engulfed in flames, with the subsequent risk to catering personnel and to fire-fighters tackling the blaze.The majority of galley fires occur at the cooking stove, or from activities associated with the stove, e.g. lighting oil stoves, smoking when refilling oil reservoir, overheating pans of foodstuffs, especially fats etc. Human error is probably one of the main contributing factors when pans of fat and such like are left unattended, the escalation into a major blaze occurring when water is used as an extinguishing agent.A limited amount of forethought and training may prevent a serious outbreak by covering the open pan with a damp cloth, so cutting off oxygen from the blaze. The destruction of the so-called fire triangle (Figure 15.3) can be readily achieved in all small fires by the elimination of heat, fuel or oxygen. Major fires will respond in a similar manner when one of the three is nullified, but it may take considerably longer than with a minor outbreak. For instance, an oil drip tray turned into a blazing inferno by the direction of a jet of water on to it within the confines of the galley, is almost impossible to control whereas oxygen could easily have been excluded by deflecting foam onto its surface. A clean,well disciplined galley area will reduce the risk of fire. Regular drills and the training of crews, especially catering personnel, in correct firefighting procedure will reduce the risk still further.

MACHINERY SPACE FIRES AT SEA

The engine room of any vessel must be considered an extremely high risk area, containing as it does certain items more susceptible to fire than any others on the ship.The majority of fires within the engine room are oil fires, Class ‘B’ or electrical fires, Class ‘C’.

When an assessment of an outbreak of fire within the machinery space is made, detail as to the type and the extent, together with the location, must be thorough.A minor oil spillage will probably be a localised outbreak capable of being tackled by portable equipment, whereas a larger oil leak, say from a broken fuel pipe, may cause an extensive fire that can only be extinguished by use of a fixed smothering system such as CO2 or foam. Once an outbreak of fire inside the engine room has been discovered, a suggested course of action would be as follows:

1. Raise the alarm, or order somebody else to raise the alarm.

2. Inform the bridge at the earliest opportunity.

3. Investigate and tackle the fire immediately, if practicable.

4. Continue to fight the fire until the emergency party arrives at the scene.

5. Rescue injured persons as soon as practicable.

6. Establish supply of equipment – foam compound etc.

7. Establish communication system, to include the bridge.

8. Attempt to contain the fire and extinguish by conventional means before use of fixed smothering apparatus.

9. Close down all ventilation, using non-essential personnel, once the alarm is raised and the location of the fire is established.

10. Close all watertight and fire doors as soon as possible after the alarm is raised.

The order of events will vary with circumstances, of course, and the recommendations given above must be used only as a guide. The actions taken by the Master, chief engineer, engineering officers etc. will also be dependent on the type of machinery and the geography of the engine room;but any machinery space fire should be tackled after investigation has shown that the approach adopted will contain and possibly extinguish the outbreak. Conventional means of fighting the fire should be continued until supplies of foam compound are consumed or the available breathing air bottle supply runs out.Then, as a last resort,CO2 or the equivalent should be injected in accordance with the fire-fighting plans of the vessel. The actions needed to extinguish an engine room fire should be taken, bearing in mind the limited supplies of conventional fire-fighting equipment on board. At the outset it should be assumed that a time will arrive when conventional fire-fighting methods can no longer be applied.To ensure the minimum amount of delay, therefore, any fixed fire-fighting installation should be made ready for operation at the earliest possible moment after the extent of the fire has been assessed.

Rescue of casualties should be a matter of priority, with due regard to the safety of rescuing personnel. Correct methods of gaining access to a fired area must be employed to prevent the fire spreading. Breathing apparatus should be employed to reduce the possiblility of further casualties. First aid parties should be ready to treat any injury, especially burns. Regular drills will ensure that personnel when attached to an emergency or stretcher party know how to recognise burns and apply burn dressings.Use of the breathing apparatus and stretchers within the confines of a compact engine room is not easy, and crew members should be exercised whenever drills are called to perform demanding tasks throughout the awkward parts of the vessel.The length of a contact line between any two fire-fighters should be tried and tested for adequacy when they are using engine room ladders. Crews should be trained to use a messenger-location guide line when advancing into smoke-filled blind areas, bearing in mind that if the fire is deep-seated, say around the bottom plates, some breathing bottles will only last about 20 minutes.

Establishing efficient communications is one of the most essential requirements of tackling a fire at sea.There must be a link up from firefighters to the support personnel and to the bridge. In order for decisions to be taken, people in authority must be kept fully informed at all times of the situation. The time to withdraw and inject, say CO2, can only be made by someone who is aware of all the facts, especially those regarding supplies of equipment, condition of personnel, location of fire, and danger of explosion.

Containment of the fire should first be attempted by use of conventional means, and the possibility of using a water spray from above the fire, as with a funnel fiddley construction,must be seriously

considered. Not only will this produce a cooling effect before the injection, say, of CO2 but also a steam cloud, causing a blanketing effect over the fire.

Watertight and fire doors should be closed as soon as possible for the safety of the vessel. Engine room personnel should be well aware of emergency and tunnel escape systems.

Summary

On the discovery of the fire, the alarm must be raised, casualties removed from the scene and the fire investigated and tackled with primary equipment. Depending on weather conditions and the location of the fire, the oil supply should be cut off, emergency parties sent to the scene, and boundary cooling should be started with the aid of emergency pumps and emergency generator.

Communications should be established to include the Master.The Con of the vessel should be adjusted to minimise draught for as long as main engine power remains available. Any fixed extinguishing system should be made ready for immediate use, the communications officer told to stand by, in the event of urgency or distress messages becoming necessary for transmission. Ventilation, fire doors and watertight doors should be sealed, and overhead cooling of the fire scene should be carried out if possible. Personnel should be aware of particular hazards regarding smoke density in an already dark area, and the possibility of re-ignition from hot metal surfaces after they have assumed the fire to be out.

Chapter 9

Fire Extinguishing Equipment

INTERNATIONAL SHORE CONNECTION: An international approved coupling is provided on board all ships so that in case of total failure of all pumps on board, sea water under pressure can be supplied by another ship or shore via this connection to the ships fire main to fight the fire. This coupling is normally kept safely on bridge of a ship so that in case of an emergency it is readily available (See diagram of international shore coupling for dimensions and the shape / size).Ships of 500 tons gross tonnage and upwards shall be provided with at least one International shore connection.

Facilities shall be available enabling such a connection to be used on either side of the ship.Standard dimensions of flanges for the international shore connection shall be in accordance to the following table:

DESCRIPTION	DIMENSION
Outside diameter (OD)	178 mm
Inside diameter (ID)	64 mm
Bolt circle diameter (PCD)	132 mm
Slots in flange	4 holes 19 mm in diameter spaced equidistantly on a bolt circle of the above diameter, slotted to the flange periphery
Flange thickness	14.5 mm minimum
Bolts and nuts	4, each of 16 mm diameter, 50 mm in length

The connection shall be of steel or other suitable material and shall be designed for 1.0 N/mm2 services. The flange shall have a flat face on one side and on the other shall be permanently attached to a coupling that will fit the ship's hydrant and hose. The connection shall be kept aboard the ship together with a gasket of any material suitable for 1.0 N/mm2 services, together with four 16 mm bolts, 50 mm in length, and eight washers.

1. **WATER SPRINKLERS FIRE EXTINGUISHING SYSTEM:** In engine room, cargo holds, accommodation, shipside tanks.

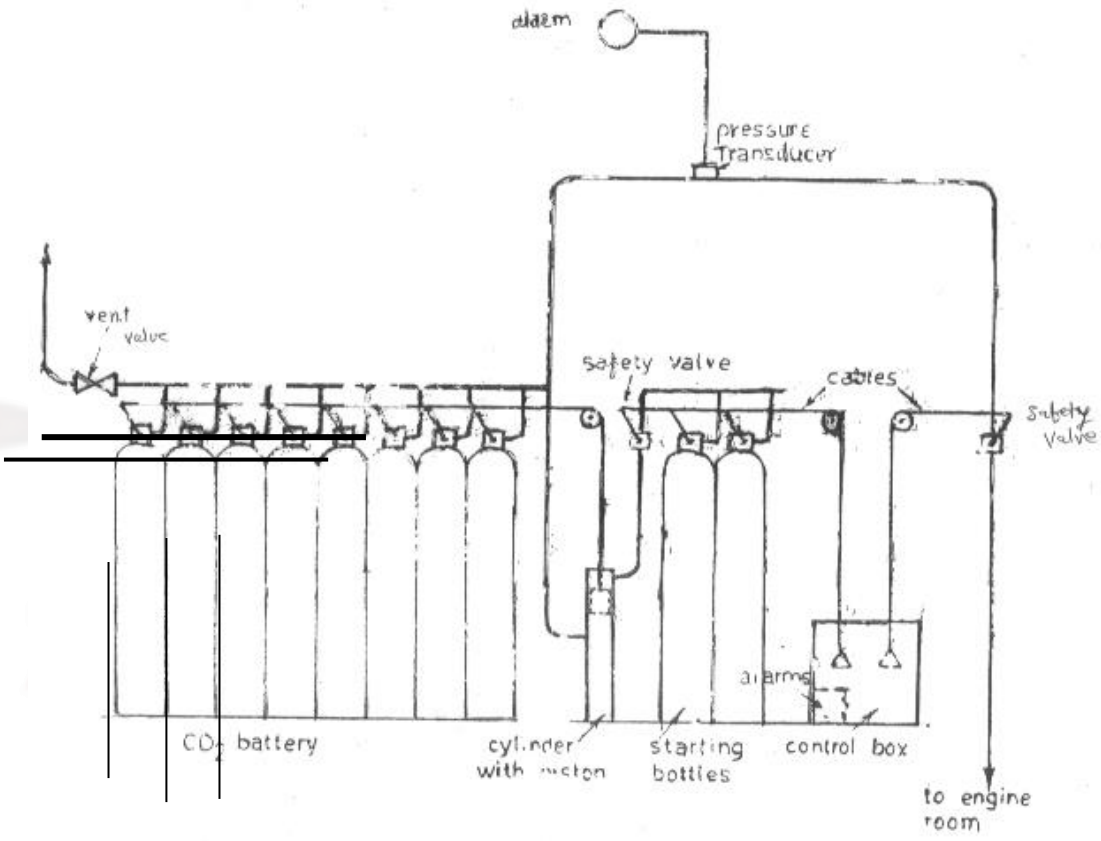
2. **FOAM (low expansion) EXTINGUISHING SYSTEM:** Deck of oil tankers, heli deck and open space)

Foam is the most suitable medium for extinguishing fires involving flammable liquids. Extinguishing is achieved by turning a layer of foam on the surface of the liquid preventing fuel vaporizing. After extinguishing the flames the foam blanket should be maintained to allow the surrounding structure to cool below the ignition temperature of the liquid. This system is used for fighting fire in the cargo space, on cargo deck, in the engine room, pump room, paint store etc. This system has storage tank containing foam concentrate. Foam is drawn from the tank by an ejector and foam solution is then conveyed through permanent pipelines to off take points.

3. **FOAM (high expansion) FIRE EXTINGUISHING SYSTEM:** In engine room, boiler room, cargo holds, pump room and paint store.

4. **DRY CHEMICAL POWDER (D.C.P.) FIRE EXTINGUISHING SYSTEM:** For interrupting the chemical reaction in metals, gas fire, electrical and electronic equipments fire. Used as fixed fire fighting system **especially in gas carriers**.

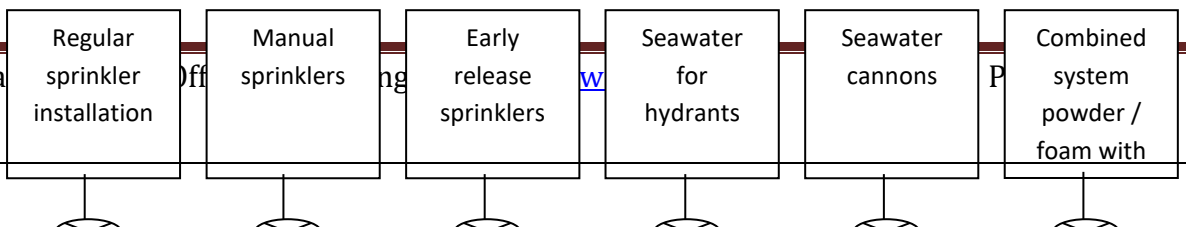
5. **CARBON DIOXIDE FLOODING SYSTEM:** This is designed to fight fire in the Engine room, Boiler room, Pump room, Control room, and Switch board etc. This system consists of a battery of a large number of carbon dioxide cylinders. The carbon dioxide is piped from the cylinder manifold to suitable point having diffusing nozzles. An alarm is incorporated in the system which when activated gives a warning to the personnel to evacuate the compartment before releasing the carbon dioxide.



CO_2 TOTAL FLOODING SYSTEM

CO_2 TOTAL FLOODING SYSTEM

6. FIRE MAIN SYSTEM (HYDRANT SYSTEM): The discharge of sea water from the fire pump is led through out the ship in a fire main line and fire hydrants are provided on the fire main line at likely spots of fire. Hoses and a nozzle are provided near each fire hydrant to direct water under high pressure on the fire. In this system, water is available under pressure to fight fire at all points in vessel. The emergency fire pump discharge can also be fed in this fire main system via an isolation valve. The fire pumps are located in engine room and emergency fire pumps are located outside the engine room so that in case of failure of main pump or the power supply, the fire main can be kept under pressure from emergency fire pump.



7. **DRENCHER SYSTEM:** Where as a sprinkler system protects a compartment from fires arising within it, drenches are located on roofs, windows and other opening in external wall to protects the place of fire from outside hazards. And the types of drenchers are as follows: -

a) Roof drenchers

b) Wall or curtain drenchers

c) Window drenchers

8. **WATER SPRINKLER SYSTEM:** It is normally installed in accommodation areas in cabins, alleyways, stairways, medical store, saloon etc. This system is always kept under water pressure. The sprinkle heads at exit points in cabins, saloons etc. are fitted with glass bulb (Quortzoid bulbs) containing high expansion fluid. In case of fire, the glass bulb containing high expansion fluid bursts and allows the water under pressure to fall like a sprinkler with low velocity. An alarm is activated, which gives the location of fire and it is also indicated on the control panel in bridge and engine room.

TYPES OF SPRINKLER SYSTEM: There are three types of sprinkler system viz. wet/dry and combination of these two systems. Wet installation is used where water is not likely to freeze (anti-ferment are added in the system to prevent icing). The dry system is used where water is likely to freeze. The alternate installation operates on wet principle in summer and dry principle in

winter.Main parts of wet sprinkler installation are main valve, NRV (Non-return valve) alarm clock valve, drain valve, pressure gauge, alarm motor union etc.Sprinkler heads are of two types:

1. FUZIABLE SOLDER
2. QUORTZOID BULB

OPERATING TEMPERATURE DEG F°	MAXIMUM ROOM / WORKING TEMPERATURE DEG C°	COLOUR OF BULBS
155	68	RED
175	79	YELLOW
200	93	GREEN
286	141	BLUE
360	182	VIOLET
440 – 500	227 - 260	BLACK

9. **PORTABLE FIRE EXTINGUISHERS:** Also known as first aid fire fighting appliances. These are for immediate use in the early stages of fire. User should not expect to deal with large fires since they have a limited duration of use and capacity. These may be divided into four categories according to the extinguishing agent (media) they contain namely: WATER, FOAM, DRY CHEMICAL POWDER and CARBON DIOXIDE. The capacity of portable extinguisher varies from 9 litres to 13.5 litres. These extinguishers are located in where there is easy access and they can be readily seen. The locations are near to room exit, corridors and stairways.

Fire Extinguisher: Portable extinguishers.

- Liquid contents should not be less than 9 liters and more than 13.5 liters.
- CO_2 type capacity of not less than 4.5 kg of CO_2.
- Halogenerated Hydrocarbon type to contain minimum of 7 Kg. BCF 1211 or BTM 1301.
- Not to exceed 23 Kg. of weight in fully charged condition.
- As far as possible to have uniform methods of operation.
- Extinguishers with pressurized contents, or those containing extinguishing media which will be harmful to personal are not to be used in Accommodation (CO_2 and Halon type).
- To be periodically inspected at intervals not exceeding two years.
- Required numbers to be kept fully charged at all times.
- Spare charges or replacement for every portable extinguisher (100 %).

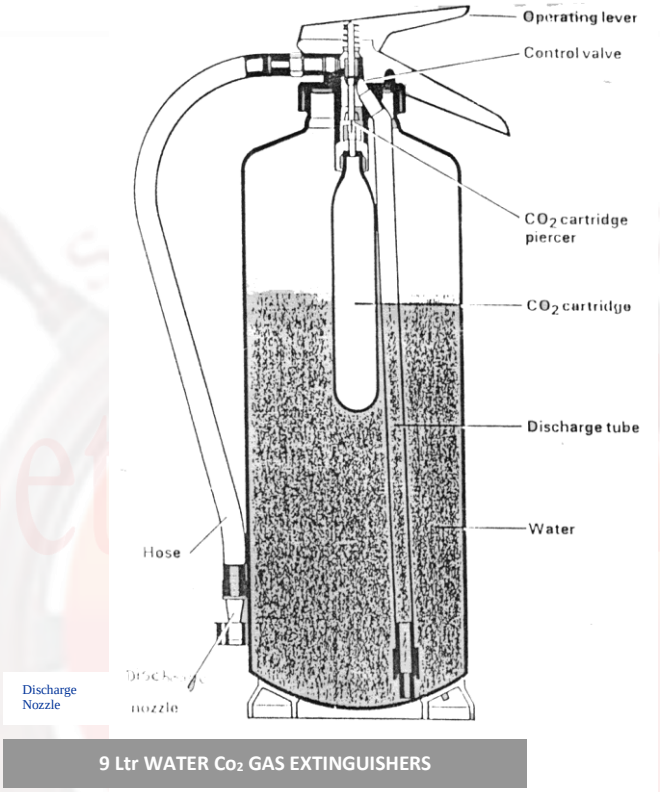
Required marking on each type of extinguisher:

- Name of manufacturer
- Type of fire for which extinguisher is suitable
- Instructions for operating
- Capacity / weight of extinguishing media
- Marks / level of liquid
- Test pressure

- Year of manufacture
- Temperature ranges over which extinguisher will operate satisfactorily.
- Date last inspected / refilled.

i) 9 LITRE WATER – CO_2 GAS EXTINGUISHER:

It is painted red. Operates for 60 – 90 seconds duration.



9 Ltr WATER Co_2 GAS EXTINGUISHERS

Range: Minimum 4 to 6 meters for at least 30 seconds.

Max. Internal Pressure: 17 bar at 21°C.

Hydraulic Pressure test: upto 24 bar, subsequent test as per regulation / manufacturer advice.

In this fire extinguisher, water is the fire fighting medium. The water is released in the form of a jet by means of gas pressure in the upper part of the container. The pressure is created by the release of carbon dioxide gas (CO_2) from a pressurized gas cartridge within the extinguisher. The gas cartridge is punctured by the plunger with spring release action.

The method of operation: - It is mostly used on carbonaceous solid flammable materials like wood, paper, cloths, ropes etc.

To Operate: - Hold the extinguisher firmly with nozzle pointing towards the fire

1. Remove safety clip
2. Strike hard on striker by hand (plunger will puncture the CO_2 cartidge)
3. Lift the extinguisher on operating position and direct the nozzle

towards the base of fire to form a jet.

Note: - Do not use this extinguisher on oil or electrical fire.

ii) **9 LITRE MECHANICAL FOAM EXTINGUISHER (ALSO CALLED LIGHT WATER):**

a) It is painted yellow has duration of 60 – 90 seconds and can cover a distance of 4 to 6 meters.

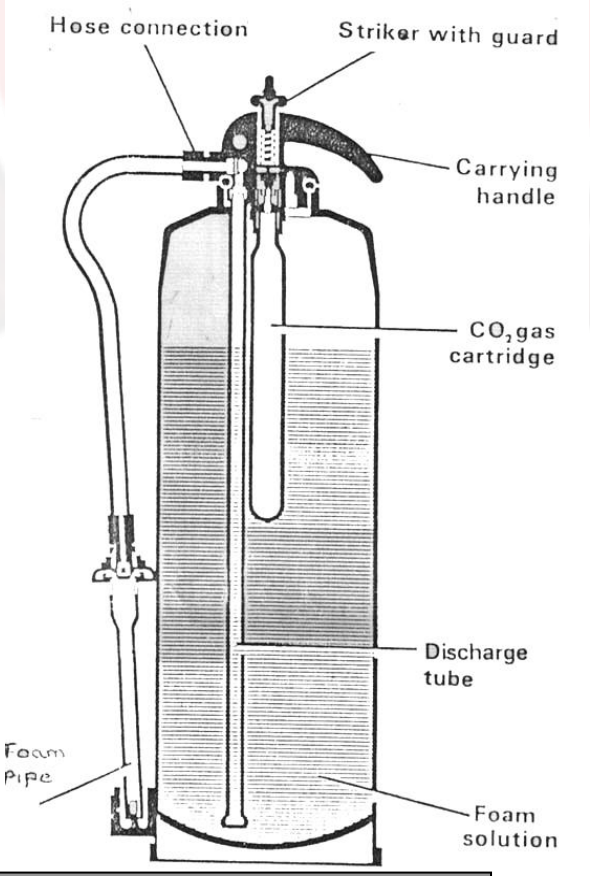
b) In this extinguisher, foam concentration is mixed as a solution in water.

c) A CO_2 gas cartridge (120 gms to 200 gms) is provided, which when pierced provides the pressure to discharge the foam solution. The solution is carried upward through the dip tube due to the gas pressure above it.

d) The solution is aerated at the discharge nozzle to form the foam.

e) The construction of the body and method of operation of this extinguisher is similar to that of a water carbon dioxide type extinguisher and discharge rate is also same as water CO_2 type of extinguisher.

Note: - Foam should not be projected directly on burning fuel. It should be allowed to drift by taking support of vertical structure.



9 Litre – MECHANICAL FOAM EXTINGUISHER (GAS CARTRIDGE TYPE)

Range: Minimum 6 meters for at least 30 seconds. Complete discharge time 90 seconds.

Max. internal pressure: 17 bar at 21°C.

Hydraulic test: Upto 24 bar, subsequent tests as per regulations / manufacturer's advice.

Charge: Protein foam / fluoro protein / AFFF compound solution.

iii) **DRY CHEMICAL POWDER EXTINGUISHER (D.C.P.):**

a) These extinguishers are used mainly for low Flash Point liquid fires and high-pressure gas fires. They have very little cooling effect.

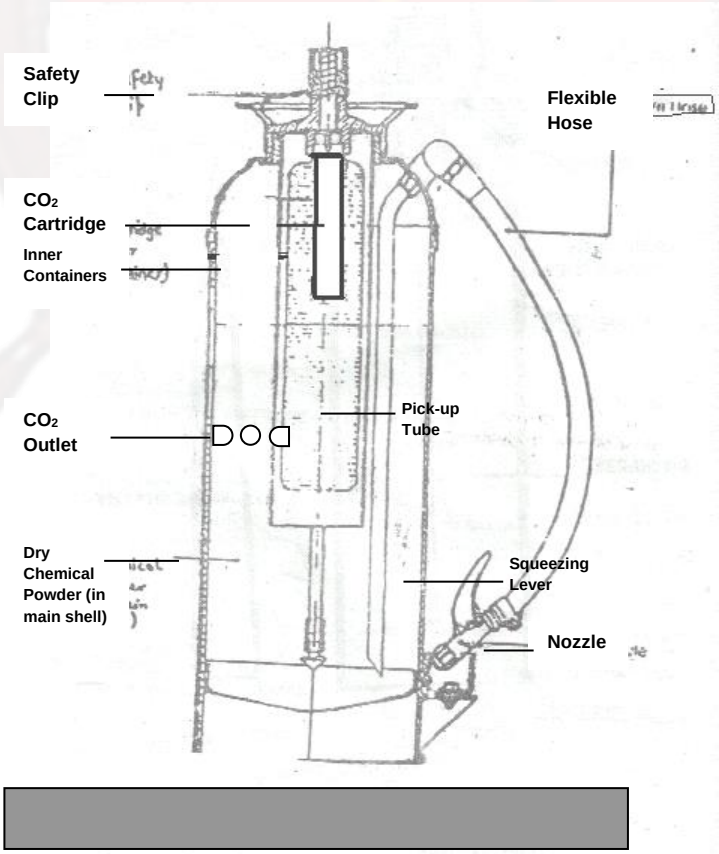
b) Dry chemical powder extinguisher is for tackling petroleum fires, gas fires, electrical equipment fires and surface of textile fiber.

c) Their action is very quick and is noticed for the speed with which they put ut fires.

d) Chemical powders are normally sodium based. When used on fire the powder under goes a chemical reaction. The free radicals, which cause and sustain fire, are put out of action by Dry Chemical powders and thus the fire is extinguished very fast.

e) For special metal (like sodium, magnesium) fires, special dry powders (T.E.C.) containing mixtures of Sodium, Potassium and Barium compounds are used to extinguish fire.

f) Above extinguishers are normally available in 1, 2, 5 and 10 Kg capacities.



iv) **5 KG. GAS CARTRIDGE TYPE DRY CHEMICAL POWDER EXTINGUISHER:**

a) It is painted blue and is used for extinguishing fire by interruption of chemical reactions.

b) See the figure for the construction of this type of fire extinguisher. The dry chemical powder (5 Kg.) is contained in the main shell of the extinguisher and CO_2 gas is held under pressure in a sealed cartridge. When the extinguisher is operated, the CO_2 cartridge (120 gms) is broken allowing the CO_2 gas escaping to the main shell and push out the powder in the form of fog.

METHODS OF OPERATION

a) Carry the extinguisher to the place of fire and keep it upright. Remove the safety clip and strike the knob located in the piercing mechanism, which in turn breaks the sealing disc of the cartridge.

b) Direct the stream of escaping powder at the base of the flame. For effective result stand about 1.5 to 2.5 meters away and direct the stream near the seat of the fire. Move forward, moving the nozzle rapidly with a sweeping motion. Useful for flight deck and helicopter landing platform, machinery spaces.

c) When using on outdoor fires, always operate the extinguisher from the upwind side of the fire to increase the effective range of the spray and to avoid the spray falling on fire fighter.

v) **CARBON DIOXIDE TYPE FIRE EXTINGUISHER (4.5 Kg.)**:

a) It is painted black and has duration of 12 – 15 seconds.

a) Carbon dioxide (CO_2) is effective as an extinguishing agent primarily because it reduces the oxygen (O_2) content of air to a point where combustion cannot continue (SMOTHERING). CO_2 is non-combustible and does not react with most substances. Being a gas it can penetrate and spread to all areas affected by air.

b) Carbon dioxide fire extinguishers are used for putting out fires on oil, petroleum products, gaseous substances under pressure and on sophisticated electrical and electronic equipment.

c) CO_2 extinguishers should not be used in fires involving chemicals that contain their own oxygen supply (e.g. Gunpowder, TNT, Cellos nitrate and other explosive chemicals which contain free O_2 atoms released during their burning / chemical action). Also for reactive metal like sodium, potassium, magnesium, carbon dioxide is of no use in extinguishing the fire.

d) **Construction:** See the figure in which the main parts of the CO_2 extinguisher are shown CO_2 is retained in the cylinder as liquid under pressure. The cylinder is filled with the charge to about two-third (2/3) by weight of its total water capacity.

METHODS OF OPERATION: Carry the extinguisher to the place of fire, remove the safety pin and operate the discharge device and unscrew the valve. Carbon dioxide is discharged through a high-pressure flexible hose and horn. Direct the jet at the base of fire and sweep across the fire surface. In open space, stand on up wind side and discharge the gas in down wind direction as close as possible to fire. For electrical fire, first switch off the power supply.

Note:

1) Never hold discharge hose or outer end of discharge horn of carbon dioxide extinguisher. Always hold from marked place only to avoid frostbite.

2) Do not lift portable carbon dioxide extinguisher above your height as these gases are heavier than air and will be directly affecting the breathing system of operator if discharge from a height.

10. **NONPORTABLE FIRE APPLIANCES**:

1. **Mobile Fire Extinguishers** (semi-portable)

a) The weight of the mobile extinguisher is more than 23 Kg.

they are also called as fire engine.

b) These are mounted on wind trolley and kept just outside the

machinery compartments.

2.a **Fire Pump**

- At least two power operated pumps.
- Each pump should be capable of delivering at least two jets of water simultaneously from any two fire hydrants.
- Discharge capacity is not required to exceed 180 m^3/ hr.
- Capable of maintaining pressure (in bar) at the hydrants for cargo ship 2.7 for 6000 ton and above, 2.5 for 1000 to 6000 ton and 2.1 for under 1000 ton.
- Passenger ship 3.1 for 4000 upward, 2.7 for 1000 to 4000 ton and 2.1 for under 1000 ton.
- Relief valve to be provided if pumps are capable of producing pressure exceeding the design pressure of fire main or other fittings.

2.b **Emergency fire pump:** Independent power and with a separate suction line to be provided. These are used for fire in E/R when main fire pumps are out of action.

- Such pumps have minimum capacity similar to that of main pump (not less than 40%) of the total capacity of all the fire pumps and not less than 25 m^3/hr capacity and capable of maintaining 2.5 bars pressure.
- Total suction head should not exceed 4.5 mtr. In worst condition.
- Diesel driven pump must start with hand cranking at 0ºC.
- Fuel tank capacity for at least 3 hours on full load and reserve for 15 hours.
- Hand cranking or approved type of alternative measure for starting at least 6 starts in 30 minutes and 2 starts in first ten minutes.

3. **Fire hoses**

Not to exceed 18 mtr for interior use and 27 mtr For exterior use and cargo spaces for the vessel of moulded breadth of 27 mtr or more.

- Made of closely woven flex, canvas or other approved material.
- Provide coupling and other fitting on either end with plain nozzle or dual-purpose nozzle.

Hose dia should not be less than 64 mm if unlined or 45 mm if lined.

- To be positioned near the hydrants.
- Provision of interchangeable hose and nozzle for each hydrant other than those required for machinery spaces one for each 30 mtr ships length or part, thereof but in no case less than five in a ship above 1000 ton.
- One spare hose with coupling and nozzle.

4. **Hydrant / Isolating Valve / Drain Valve:**

- Located so that hose can be easily attached.

- Number of position of hydrant is such as to supply two jets of water not eliminating from the same Hydrant one of which should be from a single length of hose, may reach any part of the ship normally accessible to the passenger or crew.
- In machinery space at least two hydrants one or port side and other on stbd side.

Isolating valves to separate the suction of fire main within the machinery spaces containing the main fire pumps and the rest of the fire line to be fitted in an easily accessible position out side the machinery space for tanker deck at interval of 10 mtrs.

5. **Nozzles:** 12 mm or 16 mm or 19 mm diameter nozzles to supply quantity of water as required. Jet/spray with shut off facility. One at each Hydrant to be provided.

11. PERSONNEL EQUIPMENT:

1. Water resistance protective clothing for protection against burn from radiant heat.
2. Safety shoes and hand gloves made of electrically non-conducting material.
3. Rigid helmet for protection against impacts.
4. Electric safety lamp with a capacity to work for three hours.
5. Axe with an insolated handle.

12. BREATHING APPARATUS:

1. Smoke mask with connection for air supply.
2. Air pumps or bellow for pumping air into the hose.
3. Non-collapsing type hose in sufficient length.
4. Able to reach any part of accommodation and other areas.
5. Cargo and machinery space length 36 mtrs.

13. SELF CONTENT BREATHING APPARATUS:

1. Capable of working 30 minutes and provides with one facemask.
2. Cylinder capacity of at least 1200 liters of free air.
3. Fireproof life line with snap look at least 3 mtrs. Longer than needed to reach any part of the space to be entered from an open space made of copper or galvanized tin wire rope having a breaking strength of 500 kg.
4. Adjustable safety belt or harness made of fabric.
5. Must have a bypass valve.
6. Provided with a pressure gauge with anti-busting orifices in high-pressure air supply system.
7. Maximum weight 16 kg. including lifeline, safety belt and harness.
8. Spares cylinder fully charges of 2400 ltrs of free air.
9. Ships carrying 5 sets or more the total spare capacity of free air are 9600 ltrs. or if charging facility is available spare capacity per cylinder 1200 ltrs. or total 4800 ltrs.
10. Provided with audibly warning device at 20% remaining air.
11. Provided with safety manual.
12. Operating instructions.
13. Marking of the maker and the years of manufacturers.

Chapter 10

PERSONAL EQUIPMENT

FIRE MAN'S OUTFIT

a) To approach seat of fire for fighting and to rescue, adequate protection is required against heat and smoke.

b) Every ship carries fireman's outfit consists of a breathing apparatus water resisting protective clothing, safety shoes and hand gloves, rigid helmet and electric intrinsically safe hand lamp of about three hours duration, an axe with short insulated handle, a strong fire proof line and belt for carrying the auxiliary equipment.

Fire man's outfit requirements: -

1. For the ships 500 – 2500 tons = Two sets
2. For the ships 2500 – 4000 tons = Three sets
3. For the ships 4000 tons and above = Four sets

Easily accessible and ready to use and stored in widely separated position.

c) The breathing apparatus is Compressed Air Breathing Apparatus (CABA) and smoke mask with air pump and sufficient length hose (about 36 mtr). CABA SET or SCBA (SELF CONTAINED BREATHING APPARATUS) consists of a facemask attached by a flexible hose to one or two cylinders containing air and supported on a frame and harness. The two air cylinders last for approximately 30 minutes.

d) The cylinders are connected to a reducing valve, which reduces the pressure to about 4 bars. The air then passes through a DEMAND VALVE, which further reduces the pressure and passes air to the user as he inhales and then closes as he exhales. Automatic valve releases exhaled air from the facemask.

e) When about 10 minutes of air supply remains in the cylinder a warning whistle sound continuously warning the user.

f) The facemask is of module rubber with a series of adjustable rubber straps to secure it to the head of wearer and fitted with quick release arrangements. The vision shield has a good vision and wearer does not have to turn his head constantly.

g) A pressure gauge is provided to indicate the pressure of air in the cylinder.

h) The reflex facemask, to which the demand valve is connected, incorporated an inner mask speech transmitter and fresh air valve together with the microphone communication equipment. The air supply from the demand valve on inhalation first passes across the visor to present mistling and into the inner mask on exhalation. Expired air passes out through the positively closed exhalation valve in the front of the port.

PREPARATION FOR USE OF CABA SET:

a) Fit cylinder buffer into rubber boot at base of the set, so that the valve lies horizontally. Tighten the connector into the cylinder (hand tight only). Place cylinder straps around and fit swing

bolts into forks on cylinder straps and tighten adjusting shoulder straps waist belt to full extent. Then adjust facemask harness straps to their full extent, living the center strap pre-adjusted. b) Switch off demand valve. Positive pressure facility by pressing the red buttons. To prevent damage to the positive pressure mechanism, it is important that the lever is not depressed without the rubber shroud being in position.

e) Checking the function of the BA set open cylinder valve slowly but fully. Hold breath, the unit will get balanced i.e., no audible leak. Continue breathing. It must be possible for the expired air to flow easily out of exhalation valve by breathing deeply several times. Check the function of the supplementary supply by depressing fully the center of the protective cap.

FORCED AIR BREATHING APPARATUS

a) This consists of face mask with an integral speech diaphragm, rubber breathing tube harness assembly with shackle, hemp covered with wire rope life line, signal plate, air hose, non collapsing type and double acting foot operated bellow.

b) Fresh air is drawn up the hose by the wearer's own inspiratory effort. An exhaling valve allows the escape of excess and vitiated air. The apparatus is connected to a set of bellows, which can be foot or hand operated.

1. This bellow should be situated in fresh air with the effort of a second person continuous supply of fresh air for breathing can be provided to the user for his breathing.

DISADVANTAGES OF FORCED AIR BREATHING APPARATUS

a) Constant supply of fresh air is dependent on the second person.

b) Air tubing / hose has to be trailed behind the wearer thus restricting his movement and limiting his area of operation.

c) The air hose may be cut or damaged during operation.

d) The apparatus is bulky and not comfortable, compared to breathing apparatus set (CABA set). Good care is essential to maintain the bellows in good working and unpunctual condition.

LIFE LINE SIGNALS

One pull-fire attainder asks fire fighter if he is OK. Fire fighter replies with one pull means "I AM OK".

Two pull-by fire fighter "Pay out the line, I want to proceed further". The attainder acknowledges by two pulls and pays out more lifelines.

Three pull-by fire fighter or fire attainder "Take slack on life line, I am coming out"; "Taking slack on life line you can come out".

In emergency also three pulls are given in impending danger.

Chapter 12

SHIP's FIRE FIGHTING ORGANISATION

The following information is always available on the bridge:

A) **Fire control plan**

1) A permanently exhibited plan displaying the fire protection facility on board ship.
2) Drawings giving size of ship E/R and accommodation.
3) Details of emergency escape routes / accesses from different zones of the ship.
4) Details of fixed and portable fire extinguishing equipment available on board including storage of refills.

B) **Stability information**

1) Details of survival equipment and their storage place.
2) Storage plan.
3) Information on dangerous goods.

C) **Communication method available**

1) Telephone including sound power telephone
2) Loud hailers
3) Direct speech between bridge and MCR
4) Radio telephone including walkie-talkie.
5) Messengers

D) **Method of damage control and containment fires**

1) Watertight doors operated directly from bridges.
2) Stopping of ventilation or exhaust fans and closing of dampers.
3) Closing of windows and portholes in accommodation and galley.
4) Steering ship to right direction relative to wind for fighting the fire.
5) Cooling fuel tank boundary bulkheads.

E) **Methods of ensuring stability**

1) Frequent checking change in GM (Metacentric Height) due to use of water.
2) Pumping and draining of fire fighting water.
3) Shifting of cargo to facilitate fire fighting
4) Moving to shallow water, if necessary

FIRE PARTIES: Organisation of the fire parties are as follows:

- In any emergency on board an Emergency Response Plan (ERP) goes into action. Under ERP a small well-trained team tackles any emergency that may rise. The main feature of ERP is as follows:

It defines a response to an alarm, ensure safety of life, facilitates effective communication, comply with standard procedure, it select team as required for further tackling the emergency and starts training and drill sanctions. The ERP is normally posted at the following locations.

Navigating bridge, engine room, crews accommodation and near muster stations.

TEAM AND THEIR DUTIES: The teams are formed as per pattern given below depending on the total number of personal borne on board a particular ship.

a) **Command team**

Master over all incharge

3rd Officer	:	Assistant
Radio Officer	:	Communications / Records
Helmsman	:	Steering
E/R Rating	:	Messenger

b) **Emergency team I**

Chief Officer	:	Leader on Deck
4th Engineer	:	Assistant
Petty Officer	:	As directed
Seaman	:	As directed
ERR	:	As directed
Saloon Crew	:	As directed

c) **Emergency Team II**

2nd Engineer	:	Leader
2nd Officer	:	Assistant
Petty Officer	:	As directed
Seaman	:	As directed
ERR	:	As directed
Saloon Crew	:	As directed

d) **Technical Team**

Chief Engineer	:	Leader
3rd Engineer	:	Assistant
Electrical Engineer	:	As directed
ERR	:	As directed

e) **Support Team**

Catering Officer	:	Leader
Bo'sun	:	Deputy
Seaman	:	As directed
Saloon Crew	:	As directed

f) The command team is responsible for the command and the emergency situations. To initiate search for any person not accounted for. Establishing internal and external communication and maintaining safe navigation and time event record.

g) Emergency team must first report to the command team and prepare equipment as ordered, and report readiness. This team is the first one to tackle emergency.

h) The support team musters at a pre-determined location and advises their readiness to command team and emergency team on walkie-talkie. They provide support to the command team and emergency team in preparing survival craft, breathing apparatus, additional fire fighting equipment, maintain security patrol, boundary cooling and shut-off ventilation.

i) The technical team reports their readiness to command team and give status of machinery and other emergency system and advise if any machinery has to be shut down for safety and attend to fixed fire fighting installation if necessary.

PROCEDURE FOR FIRE FIGHTING

SHIP AT SEA

- Fire alarm initiated continuous ringing on ships bell.
- Crew assembled at fire stations as per muster list.
- Fire party is assembled and prepared for action – as per orders from the bridge / master.
- Ships course and speed altered – as necessary to assist in fighting / containing the fire.
- Fire pumps started and ships fire line activated. Fire hoses with nozzle rigged up.
- Fire fighting initiated.

ADDITIONAL PROCEDURE IN PORT

- Call the port fire brigade
- Inform port authority
- Conform that port fire brigade will take charge
- Port authority to inform of hazards to the dock installation.
- Evacuate non-essential personnel.
- Make preparation to leave port, if required on power, or with the help of tugs.

ALARM AND INITIAL RESPONSE

- Irrespective of whether the vessel is at sea, anchor or in port, on hearing emergency alarm, all ship's personnel muster at their emergency station with their life jacket in long sleeve boiler suit, safety shoes and safety helmet.
- The team leaders muster the teams and report is made to the master regarding any missing person or absenteeism.