SOLAS FIRE TRAINING MANUAL

CAPT/ AHMED ELEMARY

FIRE EQUIPMENT & FIRE FIGHTING TECHNIQUES

Notes on the use of this manual

1. A copy of this manual should be available in the Officers and Crew mess room.
2. Ship specific details and / or additions should be added to section G of this manual
3. This Manual is placed on board as a crew reference document as required by SOLAS Chapter 2, Regulation 16

39. Handling liquid gas fires

G **Ship specific details**

H **Cargo Emergency Systems and Procedures**

Section A

1. Introduction

The purpose of this booklet is to provide you with information on the safe operation of the ship and cargo handling operations in relation to fire safety.

It is stressed that the information in this booklet is for guidance only. This booklet may be used as a framework and reference source for those personnel whose duty it is to give instruction in the practice of fire fighting and use of equipment. Additionally, it is intended as a reference for all personnel. In the event of a fire all staff shall muster at their allocated muster points and follow the team leader's instructions.

In addition more detailed information can be obtained by looking up the following publications, manuals, and procedures:

- Vessel's Contingency Plans
- Vessel's OMS / Safety Management System
- Vessel's Cargo Operations Manual
- Master's Standing Orders
- Chief Engineer's Standing Orders
- Chief Officer's Standing Orders
- International Safety Guide for Oil Tankers and Terminals (OCIMF)
- Liquefied Gas Handling Principles on Ships and in Terminals (SIGTTO)
- Control of Work System Manual
- Terminal requirements
- Code of Safe Working Practices for Merchant Seamen

The above Publications/Manuals are readily available on board for all to read and become familiar with. Muster lists are situated throughout each vessel. On joining, you must make yourself familiar with the following:

- Your emergencies muster station.
- Your role/duty in the team.
- Location of all fire fighting and safety equipment and the correct use of these items.
- Safety equipment that is your responsibility to maintain.

On joining the vessel, you will be given a safety tour that should identify all of the above points; in addition you will be issued with a Safety Booklet Getting HSE Right Onboard highlighting the basic safety aspects and procedures involved with the operation of this vessel.

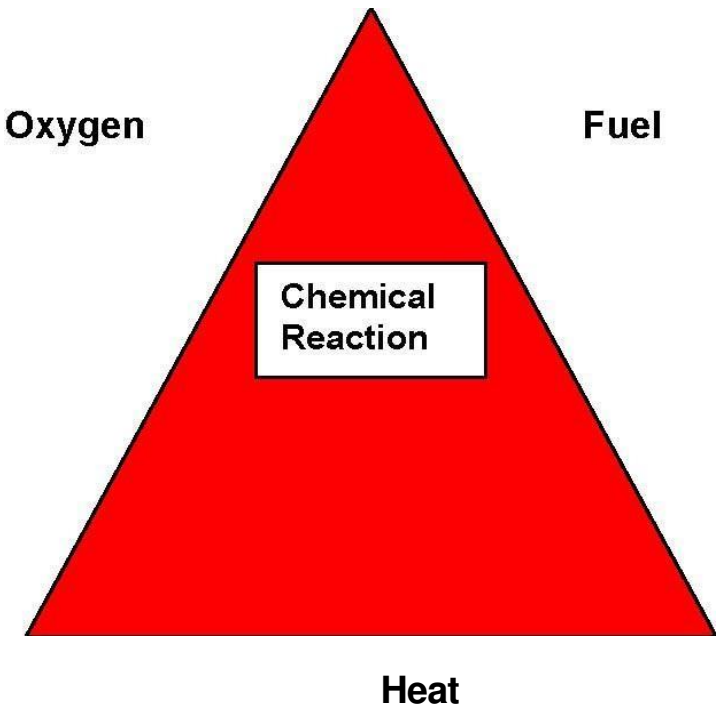
All personnel onboard have a responsibility to become familiar with the safety aspects of the vessel appropriate to their position onboard.

2. The Components of Fire

Fire is a chemical reaction known as combustion, which occurs when fuel and oxygen are brought together with sufficient heat to cause ignition.

The three components of fuel, oxygen and heat make up the sides of the Fire triangle.

The Fire Triangle



A fire cannot exist if one side of the triangle is not present, or if there is an interruption in the chemical chain reaction that sustains burning.

We will now focus on each side of the fire triangle in more detail

- **Fuel** this can take the form of either a solid, liquid or a gas
- **Oxygen** is normally present in the air in sufficient quantity to sustain a fire.
- **Heat** A critical temperature must be reached for ignition to occur. Once a fire has started it will normally maintain its own heat supply.

3. Fire Spread

Fire/Heat can be spread in four different ways.

1. **Conduction**
2. **Convection**
3. **Radiation**
4. **Direct Burning**

Conduction

Direct heat transfer through surface contact

Convection

The spread of heat via gas, liquid or hot air circulation

Radiation

Transmission of heat through the air.

Direct Burning

Where combustible materials give off sufficient vapor to allow combustion to continue when in contact with a naked flame.

4. Classification of Fires

When dealing with fire it is important you recognize its class, and select the correct extinguishing medium. Incorrect treatment of a fire can results in the situation becoming worse rather than better.

Below are details of the different classes of fire

American	**European/Australasian**	**Fuel/Heat source**
Class A	Class A	Ordinary combustibles
Class B	Class B	Flammable liquids
	Class C	Flammable gases
Class C	Class E	Electrical equipment
Class D	Class D	Combustible metals
Class K	Class F	Cooking oil or fat

N.B

Electrical fires are fought in the same way as a class A fire, but water and foam are not to be used. In fact when the electricity is shut off to the electrical device(s) involved in the fire, it would generally become a Class A fire. While the fire is, or could possibly be electrically energised, it can be fought with any fire extinguisher rated for Class C (in the US) or Class E (elsewhere).

5. Principles of Fire Extinguishing

To extinguish a fire efficiently you must remove one element within the 'Fire Triangle' (See chapter 2). This can be removed by four different methods,

Starvation
By removal of fuel from a fire it is unable to sustain combustion. This may involve the closing of valves or maneuvering the vessel to carry the heat and flames away.

Smothering
This is achieved by reducing the oxygen surrounding the fire. This can be achieved by using CO2, Foam, Sand, Fire Blankets etc.

Cooling
Water is normally used to reduce the temperature of the burning substance below its ignition temperature.

Interference
This is an autocatalytic effect that breaks the chemical chain reaction that sustains a fire. Dry Powder will achieve this.

Extinguishing media
Advantages and disadvantages of the different types:

Media	Advantages	Disadvantages
Water	Readily available at sea. Large capacity to absorb heat. Versatile Cooling agent. Cheap.	Possible effect on stability. Liquid fires may spread through the use of water. Should not be used on electrics or if live cables are adjacent. Reacts with some substances to produce toxic fumes.
Carbon Dioxide	Inert. Relatively cheap. Does not harm cargo. Does not cause toxic or explosive gases when in contact with most substances.	No cooling effect. Only a limited supply will be available. Danger of asphyxiation. Delayed deployment reduces effectiveness.
Foam	Smothers fire by forming an airtight seal. Prevents vapours escaping through seal. Foam has some cooling effect.	Only a limited supply will be available. Reacts with some substances to produce toxic fumes. Should not be used on electrics or if live cables are adjacent.
Dry Powder	Fast flame knock – down but little cooling effect. Some smothering effect. Extinguishes fire mainly by interference.	Only a limited supply will be available. No cooling properties. When discharged difficult to establish if fire is out. May react with some substances to produce toxic fumes.

6. Common causes and prevention of fires aboard ship

Smoking

Causes

- Smoking is the most common cause of fire aboard ship, due to careless smoking and improper disposal of smoking materials and matches.
- Smouldering cigarettes or matches have enough heat to ignite papers, plastics, clothing, bedding, rope, and many wood based products.

Prevention

- In-line with UK legislation smoking is only permitted in designated smoking areas on-board the vessel. Smoking is prohibited in all other locations onboard.
- All cigarette ends are to be disposed of in the correct manner; special ashtrays are available and only this type must be used.
- Company-provided safety matches are the only form of match to be used on board and the use of these matches outside of the designated smoking area is prohibited.
- The use of cigarette lighters is prohibited on board at all times

Electrical equipment

Causes

- Electrical equipment can become a source of fire aboard ship when it wears out, is misused, or is improperly wired or maintained.
- Sources of fire from electrical equipment include extension cords, power cables, or portable lights. These cords can become frayed, cut, or stretched to a point where they short out and create heat that can ignite insulation or other combustible materials, or short and spark thereby igniting combustible material.
- Makeshift wiring for personal equipment can become a source of electrical fires.
- Overloading of circuits may also cause a electrical fire
- Exposed lights especially in unoccupied rooms should be avoided as the heat from the bulb can ignite combustible materials.
- The failure of vapour tight fixtures and devices. These fixtures are designed to protect against the effect of sea air and also to prevent explosive atmosphere from entering into electrical contact with the device. Intrinsically safe equipment shall be used in atmospheres where flammable vapours are present.
- Storage batteries also pose a hazard as highly flammable hydrogen gas is released as the batteries are charged.

Prevention

- Lights should be turned off in unoccupied rooms.
- Earth test and inspect wiring normally out of sight
- Inspection of personnel electrical equipment by a competent person (ETO)
- Faulty equipment is to be removed from service and clearly labelled.
- Regular inspection of electrical equipment
- Irons are to be disconnected after use. Hot irons are not to be left unattended. The use of timer switches is recommended
- If any there is any sign of wear on any electrical cables including outer installation, the cable must be removed from service, disposed of in the correct manner and replaced.
- Power points should not be overloaded (including in cabins)
- Electrical fittings should not be tampered with by untrained personnel
- Do not push bare wires into sockets
- All safety signs relating to electrical equipment must be clear, relevant and sufficient.
- Portable electronic equipment such as mobile phones and pagers present a potential source of ignition due to their ability to generate a spark, as such they should not be openly carried or used outside of the vessel's accommodation. All ship's staff should be vigilant to ensure that visitors, e.g. Agents, Chandlers, and Pilots etc. comply with this requirement.
- Electrical lockers must not be used as storage areas.

Hot work

Causes

- Hot work is any work involving welding or burning, and any other work including certain drilling and grinding operations, electrical work and use of non- intrinsically safe electrical equipment, which might produce a spark.
- Conduction into adjacent spaces
- Ignition of materials within the work areas or adjoining work areas
- Insufficient elimination of flammable vapors, gases, or dust
- Malfunction or misuse of welding equipment.

- Flammable gases, liquids and other materials must be kept away from any source of ignition

- Welding, burning, grinding, chipping etc must only be carried out after the appropriate work permit has been issued (See the control of work system). However it should be noted that no such operation should be carried out during cargo operations.

Prevention

- Remove combustible materials or protecting materials from ignition.

- Inspect atmosphere in the working area as well as adjacent spaces for flammable vapours.

- Remove flammable vapours found in the work area or adjacent area and re-inspect atmosphere

- Ensure the space is kept free of flammable vapours throughout the operation

- Provide a fire watch around entire hot work area and adjacent spaces.

- Have the proper class of portable fire extinguisher and a charged fire hose available and ready for use.

- Do not use equipment unless you have been trained and authorised to do so.

- Check that any Oxy-acetylene hoses are not leaking securely attached and not twisted.

- Check area is clear of sharp objects which may damage any oxy-acetylene hoses.

- Check working area is clear of obstructions including trip hazards.

- Do not commence work in areas where there are surfaces covered with grease, oil or other flammable materials

- Port holes and openings through which sparks may fall should be closed.

- Gas free certificates must be issued if appropriate (i.e. Conducting hot work within cargo spaces)

- Work area and adjacent spaces are to be checked after the operation has been completed.

Galley Operations

Galley operations pose unique fire potential situations. These situations arise from energy sources, ranges and stoves, deep fat fryers and housekeeping practices.

Causes

- Primary source of energy in the galley is electric, (Please see Electrical equipment section above)

- Range tops pose threats from spillage and ignition of loose clothing

- Deep fat fryers pose a particular threat from the hot oil, which ignites readily when it comes into contact with an ignition source such as heat from a burner or open oven or the oil reaches its auto-ignition temperature. The unit can overflow when baskets are overfilled, or grease can be splattered on to ignition sources when overly wet food are placed in the fryer

- Oils and grease can build up in the galley and combined with careless or poor housekeeping can become a source of fires.

Prevention

- When working in the galley or using equipment in the ship's pantries care must be taken to avoid overheating or spilling oil or fat. Ovens or heating plates are to be turned off when not in use, and extractor flues and ranges etc must be kept clean.

- A fire blanket should be readily available by the stoves to smother fat or cooking oil fires.

- Storage of materials above the range / deep fat fryers should be avoided

- Garbage must be placed in non-combustible containers and should be segregated and stored as per the company's garbage policy. Garbage such as cardboard boxes, plastic bottles, containers and papers must never be allowed to accumulate in the galley or food preparation areas.

- The deep fat fryer should never be unattended when in operation

- The levels of cooking oils in deep fat fryers must be kept to a minimum in order to prevent spillage in rough weather.

Machinery Spaces

Causes

- Fuel oil, whether heavy fuel, diesel fuel or bunker oil poses possible sources of fire during normal operation and bunkering. Great attention is given to bunker operations, engine operation and maintenance. (Refer to Vessel QA / Safety Management System). The procedures defined in the safety management system are developed to provide a safe working environment including minimizing fire potential.

- Generally, fire potentials exist from fuel transfer systems where small leaks under pressure can atomize fuel and create a highly flammable mixture

- Machinery space bilges / save-all's pose another possible source of fire.

- Auto Ignition. This is when petroleum liquids, when heated sufficiently, will ignite without the application of a naked flame. This is most common where fuel or lubricating oil under pressure sprays onto a hot surface.

Prevention

- Any spill, no matter what or where it is, must be cleared up immediately.
- Control of rubbish within machinery spaces
- Storerooms are to be kept tidy at all times
- Use of steel bins with lids for collecting oily waste, should be emptied frequently.
- Store and use items such as cleaning fluids, paints, solvents aerosols and other highly flammable material as directed by the manufacturer.
- Safety equipment such as fuel shut-off's, baffle plates, overflow alarms, heat sensors, fire detection system must be regularly tested and kept in good working order
- Accumulations of oils should be kept to a minimum as the possibility of spark or other ignition sources getting to an oil filled bilge is a reality
- Oil saturated lagging shall be removed and personnel protected from any release of vapors during the process.
- Regular inspection of all machinery even those located outside machinery spaces

Chemical Reactions

Chemicals used for shipboard maintenance and operation are potential fire sources from chemical reaction.

Causes

- Spontaneous combustion, caused by petroleum soaked or contaminated rags stored in an area with poor ventilation. The petroleum on the rag begins to oxidize reacting with the air around it. Heat builds up from the oxidation process and the rag eventually bursts into flames.
- Reactions of mixed chemicals may be violent or cause explosions

Prevention

- Reading material safety data sheets and labels on containers should be done prior to using chemicals
- Chemicals should not be mixed together unless designed to do so
- Keep oil / petroleum contaminated materials in appropriate receptacles and dispose of these items promptly

More general fire prevention measures include but are not limited to:

- Linen and toweling must not be allowed to accumulate but shall be stored properly within a designated linen locker.
- Fluff must be removed from tumble dryers.
- Paints and paint thinners are only to be stored in a proper paint store which is equipped with a fixed firefighting system. Partly used or open tins of paint must never be left lying around.
- Paint rollers or bushes must never be 'Cleaned off' on bulkheads or decks as this leads to large accumulations of paint on the surface.
- Paint spillage must be cleaned up immediately.

7.General instructions on fire safety

The biggest fires start as a single flame and because of this taking the correct initial action in the early stages of a fire, whilst it is still very small, will maximize the chances of extinguishing it. Very often it is the actions of the person discovering the fire that can make the difference between a small blaze quickly extinguished and a catastrophic fire which could lead to the loss of a ship or loss of life.

No person on board should be in any doubt about the following:

- Action to be taken on discovering a fire
- Action to be taken on hearing the alarm
- Knowing where firefighting equipment is kept
- Knowing how to use it effectively
- Awareness of your own the other's during fire fighting

If you discover a fire (Regardless of how big or little the fire is) or smell smoke
Action to be taken

F -FIND
I -INFORM
R -RESTRICT
E -ESCAPE

OR

F -FIND
I -INFORM
R -RESTRICT
E -EXTINGUISH

If available contact the bridge, and pass on as much information as you can about the situation. Key points include if known:

I. The fire location.

II. The type of fire.

III. The size of the fire.

IV. Details of casualties.

V. What action if any has been taken?

VI. Try to extinguish the fire if possible, using the nearest appropriate fire appliance.

However, do not put yourself at risk

Raise the alarm immediately by activating the nearest fire alarm or by any other available means. Vessels are equipped with manual 'Break Glass' alarm boxes. These stations are red in colour and located at several locations on every deck. Specific instructions for operating the alarm are located on the alarm itself. An example of one of these is shown below.

- Close the door to the space containing the fire if appropriate, thus restricting the spread of fire and smoke, and then proceed to your Muster Point.
- If the vessel is in port then the port authorities and terminal should be notified. If carrying out ship-to-ship transfer operations the other vessel should also be notified.
- Cease all Cargo/Ballast operations immediately closing all appropriate valves.
- Bring main engines to standby.

Once the alarm has been sounded the crew must muster and mobilize in accordance with the vessel's contingency plans. Mustering is a critical step as a head count is taken of all the vessel's staff and it will indicate straight away if anyone is missing.

Once the emergency teams have mustered the fire-fighters / Control party must do their best to determine:

I. Where is the fire burning?

II. What is burning?

III. The extent of the fire.

IV. What combustibles are in the immediate vicinity – in all surrounding spaces and the compartments or spaces above and below?

V. Vents and other channels present that would facilitate the spread of the fire.

VI. What extinguishing method is indicated?

VII. Details of electrical equipment to be isolated.

VIII. Number and location of casualties.

IX. What is the best technique to prevent the spread of fire and extinguish .

Safety is the primary consideration when fighting any fire. It is critical that the fire fighters do not become victims.

Personal protective equipment for fire-fighters is crucial and includes: a helmet, flash hood, protective coat and trousers, gloves, safety boots, eye protection and self-contained breathing apparatus. (To be discussed in more detail later)

Buddy systems ensure that at least two individuals perform functions together. One person should not engage in the fire fighting alone. This is particularly important with hose teams as it is not safe to have one person handling a hose alone; at least two persons are required depending on the size of the hose. Each team should have a back up team equally staffed.

Means of escape is perhaps the most important safety consideration for the fire-fighters. Fire-fighters should not enter a space unless a means of escape is planned and protected. Each fire-fighter must be aware of the escape route and the potential problems associated with the loss of the escape route. Escape route hazards include watertight doors, escape trunks, and vertical ladders. Fire-fighters must be aware of maintaining access to a means of escape from the vessel (Life rafts and life boats)

Accountability during a fire fighting operation is very important. Means of accountability must be established and maintained during the fire response. Accountability must be established at the muster stations and be maintained throughout the response. The accountability system must provide a means of knowing who is engaged in the response and in what capacity they are engaged in at all times. Emergency team leaders maintain accountability for those responders in their team.

Search and rescue for trapped crewmembers is extremely important in every aspect of a fire fighting operation. After mustering and determining if any crewmembers are missing a primary or quick search can be conducted. Beyond this primary search it must be decided whether or not to expand resources for a more in depth search and rescue effort in lieu of battling the fire

Fire-fighters can use the left hand rule to find their way out of a smoke filled space by placing their left hand or body on the nearest bulkhead and continue in a forward direction without removing the left hand or body from the bulkhead. By keeping the left hand or body on the bulkhead a means of egress will eventually be located. This technique is limited in

machinery spaces due to the broken nature of the space. Crewmembers should make themselves familiar with all escape routes during their orientation. Rule - never break contact with the bulkhead.

The sooner the attack begins the more successful will be the results. The goal of the attack is to minimize the extension of the fire to areas of the ship that are adjacent on all sides above and below. Attacks can either be direct or indirect.

Gaining control of the fire is the next step. Control is established when the extinguishing agent can be applied to the seat of the fire, either by hose or extinguisher and the agent begins cooling the seat of the fire. When facing an advanced fire the fire-fighters must consider establishing boundaries (protecting exposures by cooling or other means) to prevent a fire from extending beyond the original space.

Establishing boundaries, if accomplished correctly, will usually assist greatly in getting a fire under control and extinguished without spreading to other portions of the vessel. Successful fire boundaries include all six sides of a space and may include the following actions:

- Cooling bulkheads (Boundary Cooling Techniques)
- Close doors, hatches, portholes or similar openings
- Shut down ventilation or exhaust systems from the involved space
- Remove combustibles from adjacent spaces

A direct attack utilizes an advancing fire team in the immediate fire area that applies an extinguishing agent directly to the seat of the fire. This attack is most useful when the fire is small and the affected area is easy to get to. Direct attacks usually require the support of ventilation activities to assist in removing smoke and gases and permit precise location of the fire.

Larger more advanced stage fires may require an indirect attack. This occurs when the fire has developed to a stage where superheated atmospheres eliminate the possibility of working in close proximity of the fire. An indirect attack can include the use of a fixed fire fighting system that is activated remotely. An indirect attack can also utilize an attack using a water fog or other cooling agent delivered into the space through a small opening. The result is a cooling of the atmosphere to temperatures below those necessary to support combustion.

The success of the indirect attack depends upon the complete confinement of the fire, closing doors, hatches, and shutting down ventilation systems to prevent the spread of fire.

Section B

8. Extinguishers (Portable)

Fire Extinguisher Colour Coding
Fire extinguishers are colour coded to indicate the extinguishing medium it contains. The old standard provided for the whole of the body of the extinguisher painted the appropriate colour. New extinguishers use the new standard.

a. The new standard is BS EN 3 part 5 "Portable Fire Extinguishers -Specification and supplementary tests"

b. Water extinguishers are coloured signal red.

c. Other extinguishers will be predominantly signal red with the manufacturers label, a band or circle covering at least 5% of the surface area of the extinguisher of a second colour to indicate the contents of the extinguisher.

Type	Old Code	BS EN 3 Colour Code
Water	Signal Red	Signal Red
Foam	Cream	Signal Red with a cream panel above the operating Instructions
Dry Powder	French Blue	Red with a Blue panel above the operating instructions
Carbon Dioxide	Black	Red with a Black panel above the operating instructions

Choosing the correct extinguisher

The most appropriate extinguisher should be found near any risk, but this may not always be the case, especially where there is more than one risk in the same area. For instance, in a control room there may be hydraulics, computers and other electrical equipment, paper and books. If the wrong type of extinguisher is used on a fire the already serious situation may be made considerably worse. Using a water extinguisher on a chip-pan fire could result in a contained controllable situation becoming a catastrophe as the effect of directing water into burning hot fat is to cause the fire to spread. It is important that every crew member is familiar with the advantages and limitations of each fire extinguishing medium.

Structure and information on fire extinguishers

1st Class Fire Protection
01603 742741
enquiries@1stclassfireprotectionnorfolk.co.uk

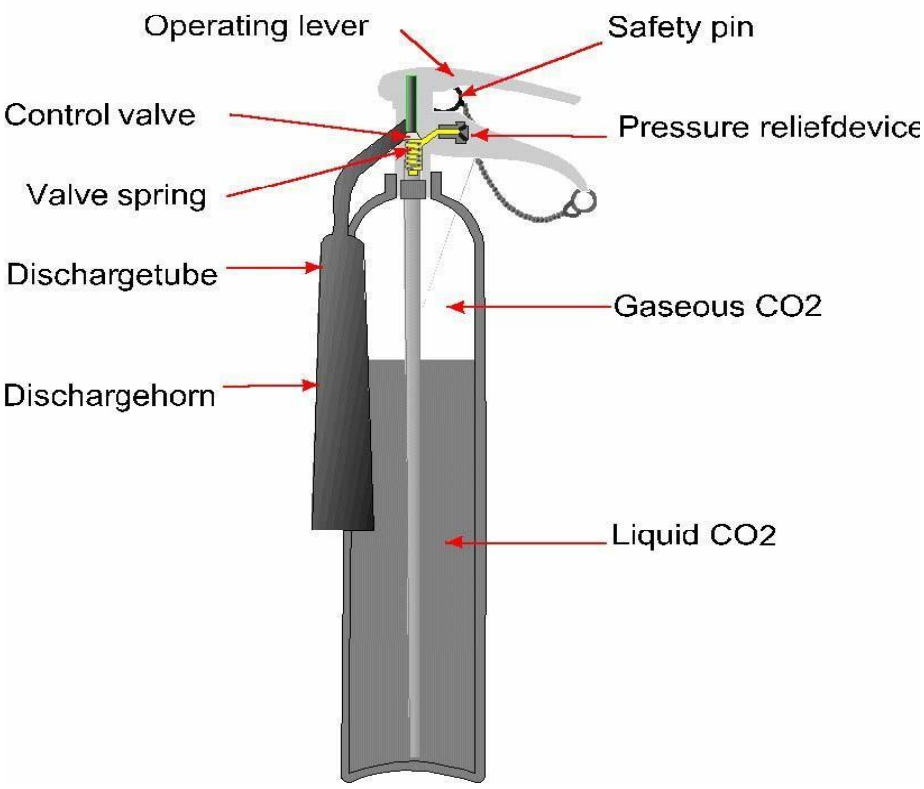
Fire Extinguisher Type

Fire Type		Powder	Foam	CO^2	Water	Wet Chemical
CLASS A	**Solids** (e.g. wood, plastic, paper)	✓	✓	✗	✓	✗
CLASS B	**Flammable Liquids** (e.g. solvents, paint, fuels)	✓	✓	✓	✗	✗
CLASS C	**Gases** (e.g. butane, propane, LPG)	✓	✗	✗	✗	✗
CLASS D	**Metals** (e.g. lithium, magnesium)	✓	✗	✗	✗	✗
ELECTRICAL	**Equipment** (e.g. computers, servers, TVs)	✓	✗	✓	✗	✗
CLASS F	**Cooking Oils** (e.g. cooking fat, olive oil)	✗	✗	✗	✗	✓
Some examples of businesses that may need this extinguisher		Outdoor locations, garages, welding workshops, forecourts.	Schools, offices, hotels, shops, hospitals, apartments.	Offices, server rooms.	Schools, hospitals, shops, apartment blocks.	Kitchens, canteens, restaurants.

The types of extinguishers which are mainly found on our vessels are foam, dry powder and Carbon Dioxide, with wet chemical used as a fixed fire fighting system in the galley. We will now look into the structure of CO2, foam and Dry power extinguishers.

CO2

Where the extinguishing medium is CO2 the gas is stored as a liquid under pressure. Because of the pressures involved CO2 extinguishers are not welded containers but solid draw. Upon discharge the liquid expands into CO2 gas. Below is an example of a cross section of a carbon dioxide extinguisher Carbon Dioxide (CO2)



Concerns with a carbon dioxide extinguisher

d. CO2 extinguishers may not be fully effective when used outside, especially in the wind.

e. Hold only the insulated parts of the discharge hose and horn. With the expansion and evaporation of the CO2 there are cooling processes and a danger of frost burn if the discharge horn is not correctly held.

f. If using a CO2 extinguisher in an explosive atmosphere stand it on the ground to ensure any electrostatic charge is dissipated.

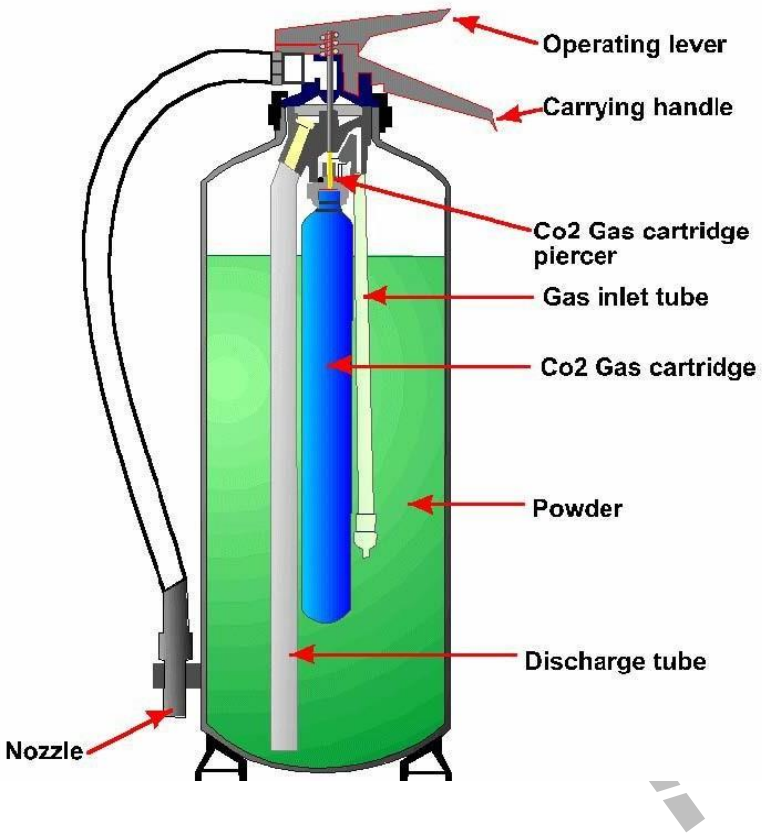
g. Don't use without a discharge horn as the discharge will then entrain air and cause an increase in the intensity of the fire.

h. Do not remain in the area after the discharge as CO2 is asphyxiating.

i. This type of extinguisher does not cool the fire very well and you need to watch that the fire does not start up again.

Dry Powder & Foam

Dry Powder & Foam extinguishers operate on the same principal. In each case the medium is stored in a welded container. When the valve is opened CO2 gas exerts a downward pressure on the foam or dry powder, forcing it up into the discharge tube and out through the discharge nozzle. The discharge will be controlled by squeezing and releasing the operating head valve. Over the page is an example of a cross section of a dry power extinguisher, a portable foam extinguisher consists of the same structure with just the extinguishing media changed.



Limitations of dry powder extinguishers

j. Safe on live electrical equipment, giving fast flame knock down, although does not penetrate the spaces in equipment easily and the fire may re-ignite.

k. This type of extinguisher does not cool the fire and care should be taken that the fire does not flare up again. Smouldering material in deep seated fires such as upholstery or bedding can cause the fire to re-ignite

l. Do not use on domestic chip or fat pan fires.

m. Avoid inhalation

n. Limitations of foam extinguishers

o. Do not use on fires where there is electricity in the vicinity

p. Check manufacturer's instructions for suitability of use on other fires involving liquids.

How to operate portable fire extinguishers

Fire extinguishers can be heavy, so it is a good idea to practice picking up and holding the extinguisher to get a good idea of the weight and feel.

Take time to read the operating instructions and warning found on the extinguishers body Once the type of fire has been determined and the portable extinguisher selected using the extinguisher can be operated using the P-A-S-S procedures listed below

P –PULL the pin that keeps the handle from being pressed at the top of the extinguisher, It's best to do this whilst still not immediately confronted by the fire. Test the range of the extinguisher at this time. The plastic or thin wire inspection band breaks easily as the pin is pulled.

A -AIM the nozzle or the outlet toward the base of the fire. Some hose assemblies are clipped to the extinguisher body. Release the hose and aim. Approach the fire keeping as low as possible.

S -SQUEEZE the handle above the carrying handle to discharge the agent. Try a very short test burst to ensure proper operation before approaching the fire. Release the handle to stop the discharge at any time.

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S -SWEEP **For dry power extinguishers** Point the jet or discharge horn at the base of the flames and, with a rapid sweeping motion, drive the fire towards the far edge until all the flames are out. If the extinguisher has a shut-off control wait until the air clears and if you can still see the flames, attack the fire again.

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For foam extinguishers for fires involving solids, point the jet at the base of the flames and keep it moving across the area of the fire. Ensure that all areas of the fire are out. For fire involving liquids, do not aim the jet straight into the liquid may only spread the fire. Where the liquid on fire is in a container, point the jet at the inside edge of the container or on a nearby surface above the burning liquid. Allow the foam to build up and flow across the liquid.

For carbon dioxide extinguishers the discharge horn should be directed at the base of the flames and the jet kept moving across the area of the fire. Be careful not to direct a forceful discharge directly into the burning material or liquid as this may only scatter it. When the fire is inside electrical equipment or inside machinery put the discharge horn against an opening or grill.

Note: Remember extinguishers have limited amounts of contents. Also if you ever use an extinguisher, make sure you lye it down and report it. Never put it back at it station.

Positioning of Fire Extinguishers

Normally, fire extinguishers should be permanently mounted on brackets or stands in conspicuous positions where persons following an escape route can easily see them, e.g. close to exits.

The intention is to encourage people to move towards the exit, rather than go further into danger. It is usual to locate extinguishers adjacent to fire alarm call points, so people can actuate the fire alarm before picking up an extinguisher.

Extinguishers should be sited so that it is not necessary to travel more than 30m to reach one.

Extinguishers provided for special fire risks should be sited near to the risk, but not so near as to be inaccessible or place the operator in undue danger from fire. E.g. In a galley, next to the door rather than next to the range.

Below the bulkhead, and in every vertical zone, there shall be at least one extinguisher available in every accommodation space, service space and control station

In enclosed accommodation spaces, service spaces and control stations above the bulkhead deck there should be at least one extinguisher on each side of the ship.

Additionally there are a minimum number of extinguishers required and portable and semi-portable are also required in machinery spaces.

Access to an Extinguisher should never be blocked nor is the extinguisher to be covered. Extinguisher should not be moved from their station.

Signs

Where extinguishers are placed in positions hidden from direct view, their location should be indicated by signs and, where appropriate, directional arrows.

Excessive Temperatures

Extinguishers should not be exposed to storage temperatures outside of the designed range. Neither should they, unless specially treated by the manufacture or protected by a specific housing, be located in places where they may be exposed to a corrosive atmosphere or corrosive fluids. Extinguishers which stand on the deck where dampness may cause corrosion should be of a suitable type and carefully monitored as to their condition.

Inspection of fire extinguishers

External inspections

- Is the safety pin in place, and operating freely?
- Examine the exterior, including the base for signs of corrosion
- Ensure that all instructions are legible and in appropriate languages
- Examine the hose and/ or horn and their securing clips for signs of cracking and damage
- Inspect the bracket for damage and ensure that it is securely attached
- Are the appropriate signs and instructions displayed adjacent to the extinguisher
- Carbon Dioxide extinguishers should be weighted and this compared against the weight stamped onto the extinguishers body or marked on the service label. If there has been a loss of more than 10% of the content weight, the extinguisher should be replaced and returned to the appropriate charging facility.
- Make sure the access to extinguisher is not blocked and the extinguishers are not covered.

Internal inspection (Foam & dry powder only)

- Discharge or empty the cylinder completely
- Internal inspection of dry powder extinguishers must not be undertaken in a damp or moist atmosphere
- Remove the cap slowly and carefully vent any residual pressure
- Empty the contents into a clean bucket and inspect the empty container for any signs of rusting.
- Use an inspection light to check the condition and any deterioration of any protective lining
- Remove the CO2 cartridge and check its condition and date. If the cartridge is expired it should be replaced. If in date check the weight against the full weight as marked on the cartridge. If there has been a loss of more than 10% of the content the cartridge should be replaced. Note: the weight loss of 10% refers to the contents not to the total weight
- Check the operating mechanism
- Ensure hoses, discharge tubes, pressure relief ports and other orifices are not obstructed
- Check that all ‘O’ rings and seals are in good condition

- Refill and reassemble the extinguisher. Lightly lubricate threads
- Some dry powder extinguishers have a burst disc fitted in the discharge hose to prevent moisture entering and affecting the extinguisher contents

Portable extinguishers must be hydraulically tested at the following intervals.

The hydraulic test period for **all types** of portable fire extinguishers should be conducted at intervals not exceeding **10 years**, unless the extinguisher is found to be defective during an inspection.

Test discharge

All portable extinguishers should be discharged on a rotation basis at intervals not exceeding 5 years preferably during a training exercise with the competent person being present during the test.

9. Extinguishers (Non - Portable)

Machinery spaces may be provided with larger fire extinguishers. These are fixed or wheeled and can be either foam or dry powder. The principle difference between these extinguishers, and fully portable units, is that they contain much more extinguishing medium but they are either fixed at one location or with limited portability.

Below are example of wheeled foam and dry power extinguishers:

On the foam and dry powder units the pressuring CO2 is used to expel the extinguishing medium and is contained in a cylinder on the outside.

We will now look each type of wheeled extinguisher in more detail.

CAPACITIES
Foam units: 45 litres or 135 litres
Dry power units: 23 – 75 kg

NON-PORTABLE FOAM FIRE EXTINGUISHERS (AS PER MSN 1665)

1. Every foam fire extinguisher, other than a portable fire extinguisher, shall be constructed of suitable materials and shall be of an efficient design and of sufficient strength to 0withstand with an adequate factor of safety the maximum internal pressure to which it may be subjected and shall be capable of withstanding a test by hydraulic press0ure suitably in excess of the maximum working pressure. The maximum working pressure shall be the equilibrium pressure that develops within the body at 70°C when the correctly charged extinguisher has been operated with all outlets closed.

2. Where the extinguisher is provided with a gas cylinder as the means for expelling the extinguishing medium, such gas cylinder shall be constructed in accordance with current British Standards

3. The extinguisher shall be provided with a nozzle and a reinforced discharge hose constructed to withstand four times the maximum working pressure specified in paragraph 1.

4. Any openings in the extinguisher body shall be fitted with caps or covers so designed that any pressure remaining in the container may be released gradually before the cap or cover can be removed completely.

5. Every part of the extinguisher shall, where necessary, be protected against corrosion.

6. The extinguisher shall be provided with a controllable device to enable the discharge to be interrupted and a means to prevent the loss of liquid when the extinguisher is standing.

7. The extinguisher actuating mechanism shall be protected so that it is safeguarded against inadvertent operation.

8. The design shall permit the ready availability of the extinguisher to be verified and ensure that it will be apparent whether or not the extinguisher has been operated.

9. A fully charged extinguisher shall when operated under normal conditions be capable of projecting foam a distance of 14 metres for a period of not less than 90 seconds in the case of an extinguisher of 135 litres capacity and over, and a distance of 10 metres for a period of not less than 60 seconds in the case of an extinguisher of 45 litres or over but under 135 litres capacity.

10. The outside of the extinguisher body shall be clearly marked in accordance with current British Standards

11. The extinguisher shall have the correct filling level clearly indicated.

NON-PORTABLE DRY POWER FIRE EXTINGUISHERS (AS PER MSN 1665)

1. Every dry powder fire extinguisher, other than a portable fire extinguisher, shall be constructed of suitable materials and shall be of an efficient design and of sufficient strength to withstand, with an adequate factor of safety, the maximum internal pressure to which it may be subjected and shall be capable of withstanding a test by hydraulic pressure suitably in excess of the maximum working pressure. The maximum working pressure shall be the equilibrium pressure that develops within the body at 70°C when the correctly charged extinguisher has been operated with all outlets closed.

2. Where the extinguisher is provided with a gas cylinder as the means for expelling the extinguishing medium, such gas cylinder shall be constructed in accordance with current British Standards

3. The extinguisher shall be provided with a nozzle and a reinforced discharge hose constructed to withstand four times the maximum working pressure specified in paragraph 1.

4. Any openings in the extinguisher body shall be fitted with caps or covers so designed that any pressure remaining in the container may be released gradually before the cap or cover can be removed completely.

5. Every part of the extinguisher shall, where necessary, be protected against corrosion.

6. The extinguisher shall be effectively sealed to prevent the ingress of moisture, but such sealing arrangements shall not interfere with the discharge of the extinguisher.

7. The extinguisher shall be provided with a controllable device to enable the discharge to be interrupted.

8. The extinguisher actuating mechanism shall be protected so that it is safeguarded against inadvertent operation.

9. The design shall permit the ready availability of the extinguisher to be verified and ensure that it will be apparent whether or not the extinguisher has been operated.

10. A fully charged extinguisher shall when operated under normal conditions, be capable of projecting not less than 85 per cent of the mass of the dry powder charge. The discharge rate shall be not less than 1 kilograms per second.

11. The outside of the extinguisher body shall be clearly marked in accordance with current British Standards

Inspection of foam and dry power units

- Check the trolley or frame for damage or corrosion
- Check the securing arrangement for the unit . This should be able to be freed in an emergency
- Is the safety pin and seal in place
- Disconnect the CO2 cylinder- if it is corroded or more than 10% below content weight it must be changed
- Disconnect the discharge hose and horn and carefully inspect them
- Ensure any nozzle operates freely
- Slowly unscrew the head cap, not more the two turns. If any residual pressure begins to escape allow the unit to slowly depressurize before completely removing the head cap
- Ensure the pressure relief holes in the head cap and pressure relief valve are clear
- Examine all washers and seals replace if necessary
- Use a thin smear of petroleum jelly on any of the threads
- In foam extinguishers check the level of the solution
- In powder extinguishers take sample scoops of powder, ensure any lumps break up immediately when lightly pressed. If the powder is caking the entire contents should be replaced
- Restore unit to a ready-use condition
- Every five years the unit should be subject to discharge test. This should be followed by a thorough inspection, including internal inspection, and recharge all according to the manufacturer's instructions

10. **Hoses**

Specifications

Fire hoses shall be of non-perishable material and shall be sufficient in length to project a jet of water to any of the spaces in which they may be required to be used. Each hose shall be provided with a nozzle and the necessary couplings and be kept ready for use in conspicuous positions near the water hydrants or connections

Tanker vessels of over 1000 gross tones must have one hose for each 30m length of the vessel, plus one spare, but not less than five hoses. (This number does not include any hoses that are required in the engine room or boiler)

Fire hoses shall have a length of at least 10 m, but not more than:

18m in machinery spaces;

27m for open decks for ships with a maximum breadth of 27m or more.

The diagrams below display some of different properties of the fire hoses we use on our vessels

TOUGH

The special compound of the rubber cover and its profiles protect the hose from damage by abrasion, hot metal contact, puncture or impact.

CHEMICAL RESISTANCE

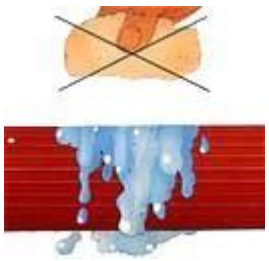
The hose is manufactured to resist a wide range of chemical products: oil, hydrocarbons, acids, alkalis, salt water, etc.

WEATHER RESISTANCE

The hose will perform at extreme temperatures (-37 C to + 50 C) and is protected against ozone, ultra-violet and atmospheric weathering.

EASILY CLEANED

The hose can be wiped down to remove dirt and grit.



NO DRYING

No need to dry the hose. The hose is mildew, rot proof and waterproof. Just clean and coil and the hose is ready for service again

Stowage and use of hoses

Hoses may be stowed, Dutch rolled (i.e. rolled from the center with both couplings accessible or flaked then placed in a hose box.

Hoses may chafe due to vibration; therefore they should be stored with minimum contact within locker interiors. The locker should be dry, and well ventilated.

Care must be taken when lying out the hose to reduce kinking. Kinking will reduce the water flow through the hose.

Avoid subjecting hoses to sudden shock loads by opening valves and hydrants slowly. Similarly avoid sudden closure of nozzles. After contact with oils, grease and after use with foam, the hose should be washed and flushed through. Make sure the hose is clean before storing it.

Pressure testing

Each hose should be tested according to the manufacture's instruction. Damaged and suspect hoses must be removed from service until it can be repaired or replaced.

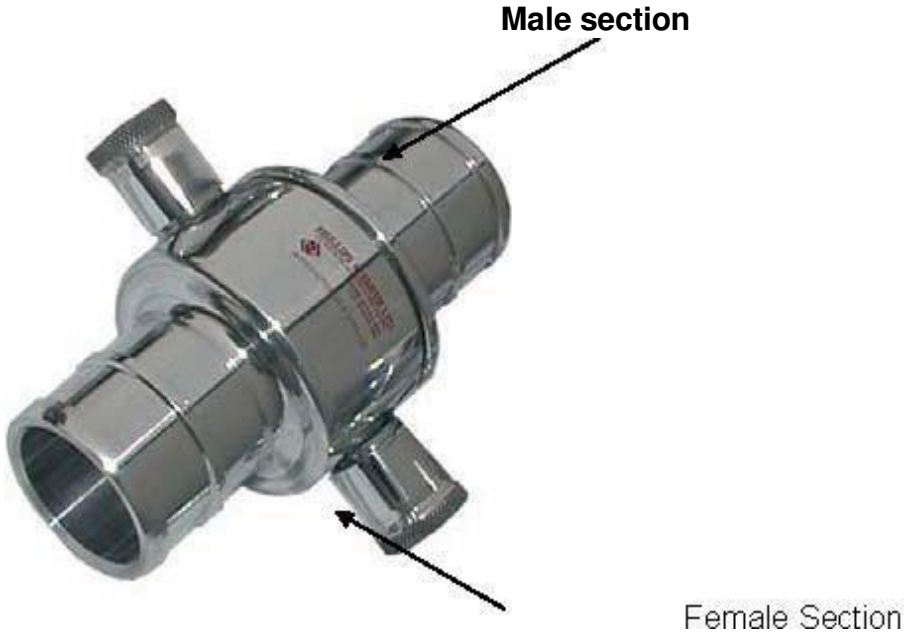
11. Hose Couplings

Fire fighting hoses are joined together and connected to the hydrants by couplings. There are many different types of coupling all of which are incompatible unless a suitable adapter is available.

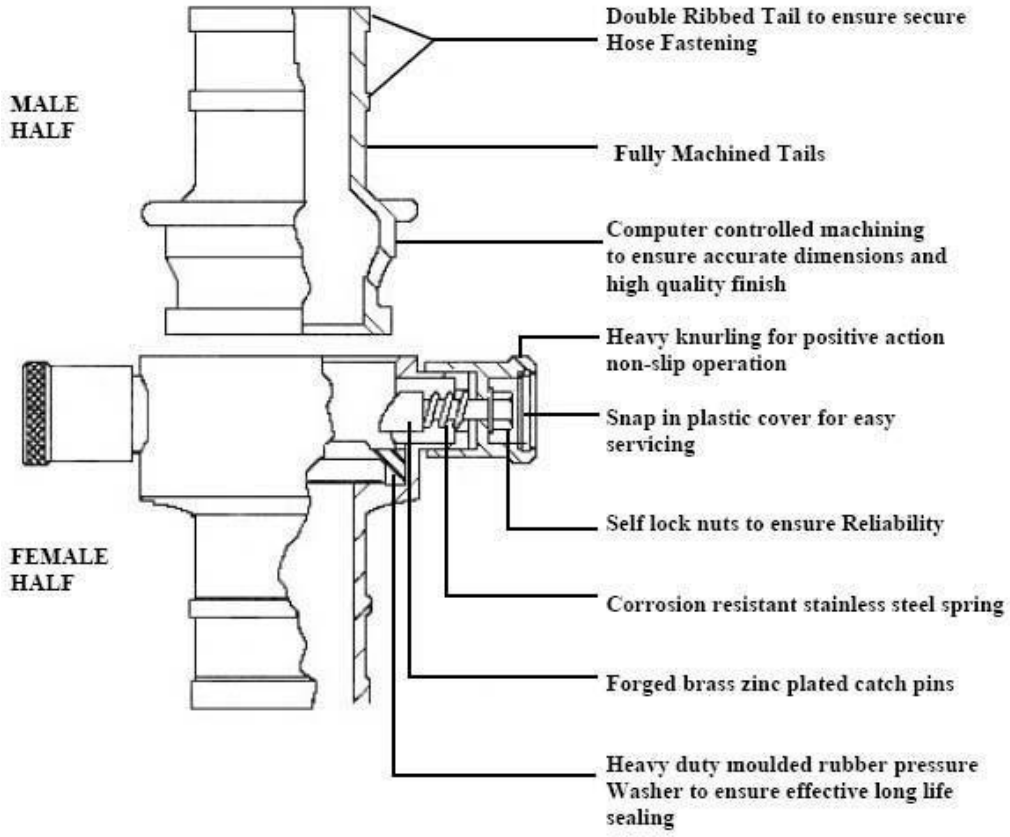
The couplings mainly used on BP vessels either the twist lock type lugged coupling or of the instantaneous kind most commonly 2.5 inch (65mm).

Instantaneous couplings consist of a male and female section of different but compatible designs. With this type of coupling each hose would have a male coupling at one end and a female coupling at the other.

The picture below show a male and female instantaneous coupling:



The diagram below is a cross section of an instantaneous coupling:



Inspection & Maintenance

- After use flush with clean fresh water
- Inspect after use or at intervals of not greater than one month
- Check any release mechanism for free movement
- Inspect the sealing rings
- Use lubricants as recommended by the manufacturer. For the bolt and spring in an instantaneous connection this may be lithium grease.

12. **Nozzles**

When in use the discharge end of the hose will be fitted with a nozzle so the operator may control the manner in which water is projected at a fire. Standard nozzles are 12mm, 16mm and 19mm.

Nozzles should be capable of a performance in the plain jet setting without undue spread, and have a throw of at least 12m. The spray setting should produce a reasonably fine spray which can be arranged to form a curtain behind which it would be possible to approach a fire. An acceptable diameter of the cone of spray would be 5m at a distance of 2m from the end of the nozzle.

When large volumes of water are used for fire fighting consideration must be given to the stability of the vessel

Pressure Discharge for Various Nozzle Diameters m^3/hour

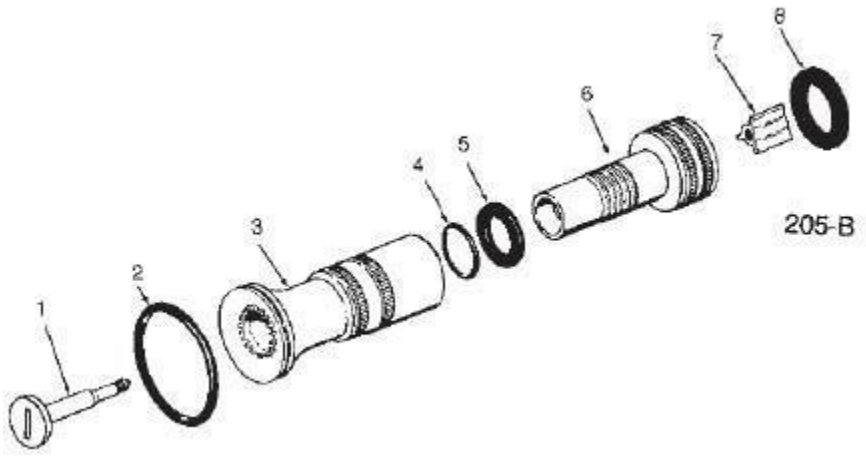
kPa	12mm	16mm	19mm
210	9	14	20.5
250	10	15	22.5
270	10.5	16	23.5
310	11	17	25

Onboard we carry two types of nozzles

1. Diffuser type nozzle. This is a standard type of nozzle which by a twist-grip operation is able to shut off the hose discharge or deliver it as a jet or spray according to the operator's desire. This type of nozzle is found in the hose box.

2. Akron Turbojet. One nozzle will be supplied to each emergency party onboard ship. These are to be used by the fire parties. This nozzle has a pistol grip, with multiple flow settings. It is easy to handle and control

Below is a cross-section of a diffuser type nozzle



Index Number	Description
1	Stem head
2	Rubber bumper
3	Nozzle tip
4	'O' Ring
5	Gasket
6	Nozzle base
7	Stem Base
8	Gasket

Below is a labelled picture of the Akron turbo

Care

Nozzles should not be dragged along the deck or subjected to knocks and blows, and they must be stowed in a manner that prevents movement. Mechanisms should be lightly greased according to manufactures instructions, always ensure that the operation of the nozzle does not become impaired by a build up of old grease.

Use of nozzles and charged hoses

All crew members should be instructed in the use of, and practice working and moving with, a fully charged hose. There must also be familiar with the various water patterns which can be delivered by adjustable nozzle.

It is recommended that at least two people should handle each hose; however three people would be advisable:

- One will handle and control the nozzle
- A second will be positioned immediately behind the first and assist by taking the weight of the hose
- A third will handle the bight of the hoses

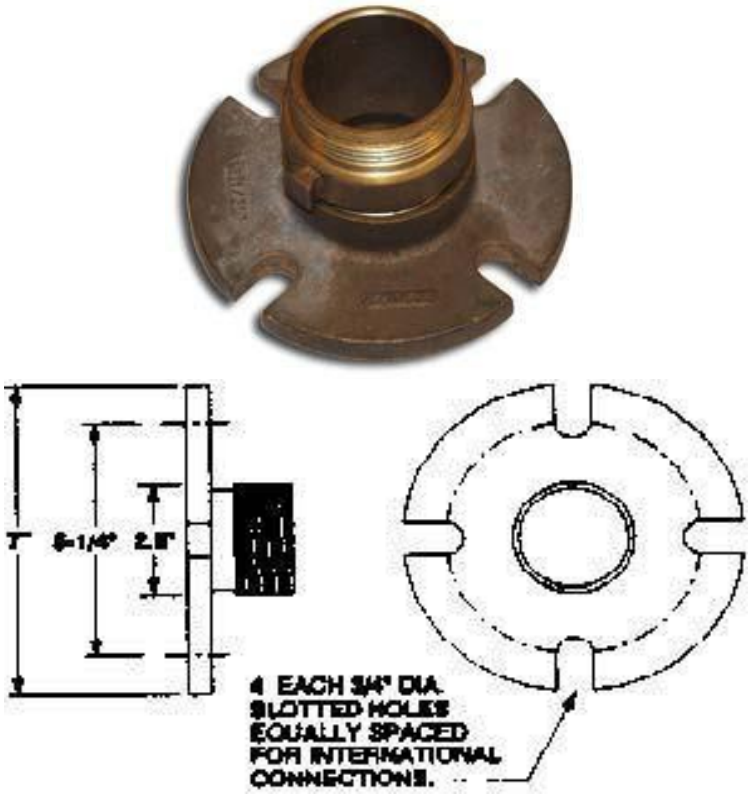
When bringing a hose into use, the nozzle should be open to full spray / water wall and directed downwards before giving the order to open the hydrant. Once the flow is established the fire fighter may change the discharge stream to that required.

We will now look at different setting of the nozzle in more detail

- Water wall / Full spray – Shields the fire fighters from radiant heat by producing a wall curtain before them. When using the water wall in close proximity to the fire some caution must be exercised, for if the water wall is to close the flames may be sucked' towards the nozzle.
- Wide Spray – For close attacks and indirect application. Indirect application is the use of very short bursts of water into the heat layer above the fire. It is used where a direct attack may cause sufficient air movement to force the heat collected at the deck head back down round the fire fighters.
- Narrow Spray – This may be used to control a fire and push it away. By directing a narrow spray across an opening or through an opening a venture effect is created, which may assist in dispersing smoke, fumes and heat.
- Broken Spray – Is used from a distance when cooling is required.
- Jet – Gives the greatest reach. This enables the fire fighters to keep a safe distance from the fire. It is used to penetrate and, where required to break up debris. A jet should not be used during interior attacks until the heat has been controlled and dissipated. A jet is not to be used on oil or liquid fires.

13. International Shore Connection

Vessels of over 500 tons must carry at least one international shore connection to enable water to be supplied from another vessel, or from the shore, to the fire main. It must be possible to use the connection on either side of the vessel.



The international shore connection shall be in accordance with the following specification - Details of flange

The connection shall be constructed of material suitable for 1 MPa service. The flange shall have a flat face on one side, and to the other there shall be permanently attached a coupling which will fit the ship's hydrants and hose. The connection shall be kept aboard the ship together with its gasket, bolts and washers.

Outside diameter:	178 millimetres
Inner diameter:	64 millimetres
Bolt circle diameter:	132 millimetres
Holes:	4 holes of 19 millimetres in diameter equidistantly placed, slotted to the Flange periphery
Flange thickness:	14.5 millimetres minimum
Bolts:	4 each of 16 millimetres diameter; 50 millimetres in length with washers
Flange surface flat face	
Material:	any suited to 1 MPa service
Gasket:	any suited to 1 MPa service

13. Foam making equipment

Foam is used when water alone is not sufficient as an extinguishing agent. Foam works by forming a blanket of bubbles on the burning fuel and excludes oxygen thus stopping the burning process. Foam extinguishes fire in the following ways:

a. Separating - creates a barrier between fuel and fire
b. Cooling - lowers the temperature of the fuel and
c. Smothering - Prevents the release of flammable vapors and reduces the possibility of ignition or re- ignition

Foam requires time to be effective. The amount of life a foam blanket has is impacted by the following variables:

d. Type of fuel
e. Type of foam concentrate
f. Heat of fuel surfaces
g. Resistance of foam to re-ignition
h. Degree of rolling of the vessel, causing foam blankets to mix with fuel and edges of blankets to contact hot surfaces
i. Obstructions to free flow of foam to cover the entire burning surface

Foam resists disruption due to wind and draught, or heat and flame attack, and the foam blanket is capable of resealing after an incursion. Foams are arbitrarily divided into low, medium and high ranges of expansion

Low Expansion - Expansion in volume of up to 20 times the quantity of water used

j. Long range jet High cooling effect even on vertical surfaces due to its sticking effect

Medium Expansion Expansion 20 – 200 times

k. Limited range of jet Layers up to 3m Capable of pushing well forward and going round
Corners

High Expansion - Expansion 200 – 1000 times for rapid filling of large spaces

l. Layers up to 30m
m. Capable of pushing well forward
n. Effective vaporization control within bounded areas

Fixed foam flooding systems for machinery spaces may use high expansion systems, but deck foam systems and portable marine systems use low expansion systems having an expansion ratio of seven or eight times the volume of the water supplied. The maximum permitted expansion ratio for a deck marine system is twelve times.

General foam application techniques include:

o. Having an individual or spotter to one side to direct the application because the nozzle person may not see where the stream is going
p. Do not plunge the stream directly into the fuel, it may splash and cause the fuel and fire to spread
q. Apply sufficient foam to cover the surface of the fire
r. Allow time for fuels to cool

s. Pre-cool with fog spray to reduce flame radiant heat before applying foam if a fire is very hot. Do not apply fog and foam together or fog where a foam blanket already exists.
t. Do not walk through a foam blanket because the surface may release vapours and re-ignition may occur.

Foam is applied in using one of three techniques:

1. Bank down or bounce off method where the foam is deflected off a bulkhead or other obstruction. The foam is allowed to run down onto the surface of the fuel

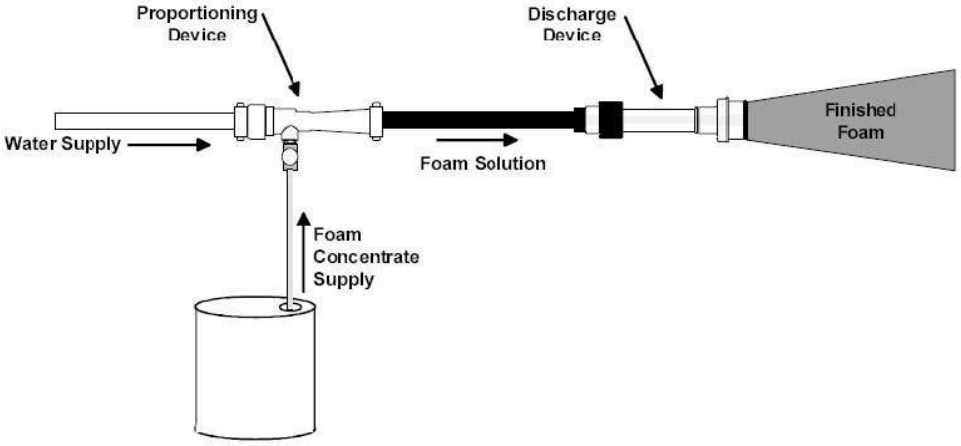
2. Roll – on method is accomplished by directing the foam on the deck near the front edge of a burning fuel and allowing the foam to accumulate and roll across the fuels surface. Foam is applied until it spreads across the entire surface of the fuel

3. Rain down method is where the nozzle is directed into the air above the fire and the foam stream is allowed to reach its maximum height and breakdown into smaller droplets falling gently down onto the surface of the fuel. This method is ineffective in high winds.

Production of foam

Portable foam producing appliances consist of foam making branch pipe, an in-line inductor and a supply of foam concentrate. The inductor mixes the foam concentrate with water at the right percentage and the branch pipe mixes the resultant foam solution with air

Diagram showing induction from the branch pipe



Induction

The foam concentrate is introduced into the water flow via a pick up hose and by means of Venturi suction caused by the pressure drop across the inductor. In-line inductors may be fitted with an on/off valve and a means to vary the amount of concentrate introduced into the system.

The induction may either occur directly at the branch pipe or, by use of a separate in-line inductor, at or near the fire hydrant. This latter arrangement allows the fire fighter greater mobility as he is no longer inhibited by the foam concentrates containers and pick up tube.

Below is an example of an in-line inductor.

Rigid end of pick up tube for in drum of foam concentrate.

14. Foam making equipment

The mixed water and foam concentrate is passed to the branch pipe which entrains air into the solution and delivers foam.

Below is an example of a branch pipe.

The advantages to this type of branch pipe are as follows:

- Safe and easy to operate.
- Minimal man power required.
- Light weight and easy to handle.
- Efficient foam concentrates consumption.
- Produces good quality foam.
- Minimum maintenance required.
- Tough and corrosion resistant for a long lease of life.

Hoses and couplings
The hoses and couplings used for portable foam equipment will be the same type already disused in chapter 10 and 11.

15. Fireman's outfits

Fireman's suits are designed to protect the skin from heat radiating from a fire and from burns and scalding by steam. They are manufactured from material which is flameproof, water resistant and easy to clean.
It is important that the suits are comfortable and allow the fire-fighter freedom of movement.

Firemen's equipment should be stored where it is accessible but in positions which are not likely to be cut off in the event of a fire.
The fire suit consists of:

- Trousers – with braces
- Jacket
- Safety helmet
- Gloves
- Boots
- Flash Hood

Trouser and jacket
This range provides the fire fighter with improved fit, wearer comfort and less weight without compromising levels of operational protection.
The fabric used reduces internal body heat build-up for greater safety under extended operational conditions.
Below are picture of the fireman suit


Safety Helmet - Bristol Jet style Fire-fighters Helmet

- Manufactured from pre-impregnated glass fiber.
- Multi-sized helmet adjusted by ratchet system.
- Helmet is supplied complete with visor manufactured and with visor shield.
- Provides neck protection

Marine firefighter package

There are specific SOLAS/MED requirements for marine fire-fighting as well as flag state approval requirements. VIKING can supply a full package of approved products as needed for your fleet.

Firefighter helmet
Item no.: 1027490
See page 53

Self-contained breating apparatus (Incl. cylinder)
Item No.: 1063019
See page 62

Spare cylinder for SCBA
Item No.: 1052383
See page 62

Fireman waistbelt
Item No.: 1043103
See page 53

Firefighter gloves
Item No.: 1067818
See page 52

Pouch for firefighter axe
Item No.: 1020780
See page 53

Short firefighter axe
Item No.: 1048027
See page 53

Long handled firefighter axe
Item No.: 1068844
See page 53

Firefighter suit
Item No.: PS1162 / PS1122
See page 50

Firefighter boots
Item No.: S-5260170XX
See page 52

UHF Handheld Radio
Item No.: 1065133
See page 66

Torch light
Item No.: 1058219
See page 36

51

Gloves – Firestar Glove 20

- Leather outer (1.2 mm)
- Reinforced palm and thumb
  Gore-Tex membrane
- Seamless knitted Kevlar/FR Viscose lining with Viloft plating to wick moisture away from hand
- Kevlar/Nomex wristlet cuff
- Sewn in Nomex thread

Boots – Bristol

Electrically non-conducting with toe caps
Heat and oil- resistant sole

Extra equipment Fireman's lamps – Bristol

Fireman's lamps are battery operated and must have duration of not less than three hours. The batteries must be of the appropriate type as specified on the torches ATEX certificate and the hand lamps must be fitted with means for easy attachment of the lamp to the user.

The above lamp is the one which is supplied to the vessels; it is a right-angled lamp which

can be attached easily at waist height. The features of this lamp include:
Two-cell safety torch for use in hazardous industrial atmospheres - it is intrinsically safe.

Fireman's Axe – Bristol

Each fireman's outfit onboard will have a fireman's axe attached. See below
One side of the head has a cutting edge the other side a spike. A belt and pouch allows the fire fighter to carry the axe and keep both hands free. The axe has a steel head and shaft and the handle is insulated to 20,000 volts.

Lifeline – Bristol

Lifelines are provided in each emergency team. See below

- Length 40m (120 ft).
- Snap lock one end.
- Steel core with hemp cover.
- Safety harness may also be attached to the snap lock.

16. Breathing Apparatus

Compressed breathing apparatus allow safe entry into compartments which do not contain sufficient oxygen to sustain life, or which contains life threatening gases. The wearer of the BA set must feel comfortable and confident with the set.

Every self-contained breathing apparatus shall be of the open circuit compressed air type and shall be of a type which has a Certificate of Assurance issued by the Health and Safety Executive in compliance with the requirements of the Joint Testing Memorandum of the Health and Safety Executive, the Department of Environment, Transport & Regions and the Home Department.

Every self-contained breathing apparatus shall be provided with not more than one face mask unless the apparatus has been certified by the Health and Safety Executive for use with a second face mask which may be used in extreme emergency.

The storage capacity of the compressed air cylinder or cylinders attached to the apparatus and carried by the wearer shall be at least 1,200 litres of fresh air. The storage cylinders shall be constructed of suitable material and shall be of efficient design and of sufficient strength to withstand with an adequate factor of safety, the internal air pressure to which they may be subjected, and each cylinder shall be capable of withstanding a test by hydraulic pressure suitably in excess of the maximum working pressure.

Means shall be provided for the automatic regulation of the air supply to the wearer of the apparatus in accordance with his breathing requirements when he is breathing any volume of free air of up to 85 litres per minute at any time when the pressure in the supply cylinder or cylinders is above 1.05 MPa. Means shall be provided for overriding the automatic air supply to increase the volume of air available to the wearer if required.

A pressure gauge with an anti-bursting orifice shall be incorporated in the high-pressure air supply system to enable the wearer to read directly and easily the pressure of air in the supply cylinder or cylinders.

The maximum weight of any such apparatus shall not exceed 16 kilogram's, excluding any lifeline and, if they do not form an integral part of the apparatus, any safety belt or harness.

Every self-contained breathing apparatus shall be provided with fully charged spare cylinders having a spare storage capacity of at least 2,400 litres of free air except that

i. if the ship is carrying five sets or more of such apparatus the total spare storage capacity of free air shall not be required to exceed 9,600 litres; or

ii. if the ship is equipped with means for re-charging the air cylinders to full pressure
- with air, free from contamination, the spare storage capacity of the fully charged
- spare cylinders of each such apparatus shall be of at least 1,200 liters of free air,
- and the total spare storage capacity of free air provided in the ship shall not be
- Required to exceed 4,800 liters.

A servicing and instruction manual shall be kept with each such apparatus.

Every breathing apparatus shall be constructed of materials having adequate mechanical strength, durability and resistance to deterioration by heat or by contact with water and such materials shall be resistant to fire and shall not allow the breathing circuit to be penetrated by smoke or chemical fumes likely to be encountered in service. The fabric used in the construction of any harness provided with such apparatus shall be resistant to shrinkage. Exposed metal parts of the apparatus, harness and fittings shall be of materials so far as practicable resistant to frictional sparking.
The following equipment shall be provided for use with each set of breathing apparatus:

i. an adjustable safety belt or harness to which such line shall be capable of being securely attached and detached by the wearer by means of a snap-hook;

ii. means for protecting the eyes and face of the wearer against smoke; and

iii. plates of suitable non-flammable material bearing a clearly legible code of signals to be used between the wearer and his attendant, one of which shall be attached to the safety belt or harness and another attached to the free end of the life-line;

Every breathing apparatus shall be clearly marked with the name of the maker or vendor and the year of manufacture.

Draeger BA sets are to be found onboard. Details of the sets are found below

Carrying system

The Draeger sets have an orthopedic designed, anti-static back plate made from a high strength chemical and impact-resistant moulded composite material. The set has padded shoulder straps to provide the wearer with extra comfort and, by adding the waist pad; weight is concentrated at the body's centre of gravity - the hips - to reduce back strain, stress and fatigue.

The shoulder pads and the waist pad are constructed from a closed cell foam inner core with high aramid content covering material.

The harness is constructed from Polyester and Modacrylic/Kevlar to give a balanced combination of strength and temperature resistance.

Moulded handles on the back plate provide greater manageability when transporting the set. There is a simple pull sideways adjustment for the waist belt with a quick connect polyamide buckle and independent shoulder adjusting straps.

Cylinder Strap

There is a secure, proven, cam-lock mechanism and a composite material strap for strength and reliability. No tools are required for adjustment.

Demand Valve

The Demand Valve provides a stable and consistent supply of air on demand and is extremely quiet in use and is positive pressure, first breath activated. It comes complete with a wrap around silicone cover for added impact protection and is easy to service, clean
and disinfect. There is a 'switch off' push button which is centrally positioned and contoured for easier location.

Whistle & Pressure Gauge:

A pressure gauge enables the wearer to ascertain the pressure of air remaining in the cylinders at any time.
A warning whistle indicates to the wearer that the cylinder capacity is low and that he should remove himself from any unsafe atmosphere. The gauge is fully luminescent.

Maintenance

Inspection and maintenance of any self-contained breathing apparatus must be carried out by a competent person and strictly in accordance with the manufactures instructions.

Pre-Donning Checks

Each BA wearer should have an attendant to check the set is properly donned and tested before entry. Checks should always be as per the manufacturer's specific instructions but as the points below give a general guide.

Visual inspection - Check the cylinder and inspect equipment for damage. Face mask is fitted correctly. Does the wearer have all other equipment required such as lamp, axe, radio etc.

Cylinder contents - Gauge should read at least 80% of maximum. Wearer should be able to read his/her gauge

High-pressure leak -Check contents. Close cylinder and wait for 2 minutes. Pressure should not drop more than 20 bar.

Whistle - Slowly release air pressure. Watch contents gauge fall. Whistle must begin to sound at no less than 50 bar.

Mask fit - Keep cylinder closed. Place mask over face and breathe suck mask against your face. Air should not leak into the mask. Re-open cylinder and lift face seal, air should flow continuously whilst seal is broken.

Note. This is not the procedure taught by the manufactures or onboard. Please see amendments below.

1. Visual inspection - Check the cylinder and inspect equipment for damage. Activate the reset feature of the LDV to ensure that the positive pressure Facility is 'Off'.

2. Cylinder Content Check: While holding the contents (pressure) gauge in one hand, slowly 'open' the cylinder valve fully. A momentary sounding of the whistle warning unit will occur during pressurization of the system. Check the pressure reading of the cylinder contents gauge. Safety Note: - Never use a cylinder with less than 80% capacity. e.g. 300bar capacity = 240bar

3. High Pressure Leak Test 'Close' the cylinder valve. After one minute observe the contents gauge and reopen the cylinder valve – the pointer of the gauge must not increase in pressure reading more than 10bar (10bar is acceptable) – i.e. one radial marking on the gauge face. Note - during this test don firemen's outfit.

4. Don the face mask, ensuring the neck strap is in place. Place your chin in mask and adjust the bottom 2 straps then the middle and so on. Make sure the straps are not twisted and the mask fits on your head. Safety Warning: - Facial hair, beard stubble, side whiskers and the wearing of spectacles will adversely affect and interfere with face piece seal. Correct fit of face piece is ensured only if the face piece seal makes close contact with skin.

5. Whistle Warning and face seal test. Hold the gauge in one hand and slowly close the cylinder gauge fully. Breathe gently and to exhaust the cylinder contents. The whistle should activate between 60bar to 50 bars. Continue to breathe down until the face piece pulls onto your face. Hold your breath for 3 -5 seconds. If the face piece remains on your face then you have a seal. Immediately open fully the valve and breathe normally Safety warning. Do not remove your hand from the cylinder valve until the test is completed.

6. Positive Pressure Balance Test. Inhale and hold your breath. Whist holding your breath listens for audible leaks. There should be no leaks.

7. Supplementary Supply Check. Press the centre of the rubber cove of the LDV, there should be a rush of air. Release and breathe normally.

Using the set

In order to minimise the amount of air used:

- Train frequently
- Be familiar with the use of the equipment
- Control breathing so that it is steady. Panting and 'Panic' breathing will reduce the available time.
- Personnel should be clean shaven, to provide a good seal around the mask
- Do not use air unnecessarily (e.g. while waiting to enter a compartment)
- Be familiar with the area to be entered

Other factors affecting the amount of air consumed include age, fitness, state of health, smoker/non-smoker, state of mind, overall work rate. A rough guide to the duration of a cylinder is given by assuming an average air consumption of 40 litres per minute. A safety margin of 10 minutes should be applied.

After use:

- After each wear, it is necessary to ensure that it is stowed in a condition whereby it is ready again for immediate use. Manufacturers instructions must be followed, these will include
- Clean the set thoroughly throughout
- Clean the face mask and harness using the manufacturers cleaning wipes, or warm soapy water if not available.
- Inspect the complete set for damage and loose fittings
- Fit a fully charged cylinder
- Complete high and low pressure checks
- Re-stow the equipment in a ready to use condition.

Air Compressors

Air compressors are carried onboard for the sole purpose of recharging compressed air cylinders. These units do vary between ships, please refer to the manufacturers operating manual. This equipment must only be used by a competent person. The air intakes must be sited so that the ingress of water or noxious fumes is avoided.

BA Controller

The BA controller plays an important part in overseeing the safety of the BA wearers. The BA Controller must be fully conversant with the use and limitations of BA equipment. It is preferable therefore that the controller is an Officer.

BA controller must:

- Assist with the donning of the sets
- Observe the operational and face seal checks
- Make entries on the control board and ensure that the tally system is being correctly operated
- Determine the point of securing any life line (If used)
- When a wearer has not returned at the appointed time inform the officer in command

and initiate the emergency plan

- Have a stand by party ready which consists of two BA wearers
- Keep the commander fully informed of the situation

Tallies and control boards

It is important that there is a system of recording the times BA wearers enter an incident and the times that they are due out. A tally or control board is used

Tallies – Each BA set is provided with a tally on which is marked.

I. Name of ship
II. BA cylinder number
III. Name of wearer
IV. Cylinder pressure at time of entry
V. Time of entry

The tally is completed by the wearer and checked by the controller. It is then placed on the control board. On the control board adjacent to the tally is marked the time the BA wearer's whistle is expected and time he is due out. The tally must be returned to the wearer when they exit the area.

17. Emergency Escape Breathing Apparatus

All ships shall carry at least two emergency escape breathing devices within accommodation spaces and one spare set.

Within the machinery spaces, emergency escape breathing devices shall be situated ready for use at easily visible places, which can be reached quickly and easily at any time in the event of fire. The location of emergency escape breathing devices shall take into account the layout of the machinery space and the number of persons normally working in the spaces.

The number and location of these devices shall be indicated in the fire control plan.

An EEBD is a supplied air or oxygen device only used for escape from a compartment that has a hazardous atmosphere.

EEBD's shall not be used for fighting fires, entering oxygen deficient voids or tanks, or worn by fire fighters. In these events, a self-contained breathing apparatus, which is specifically suited or such applications shall be used.

The EEBD shall have, a service duration of at least 10 Min.

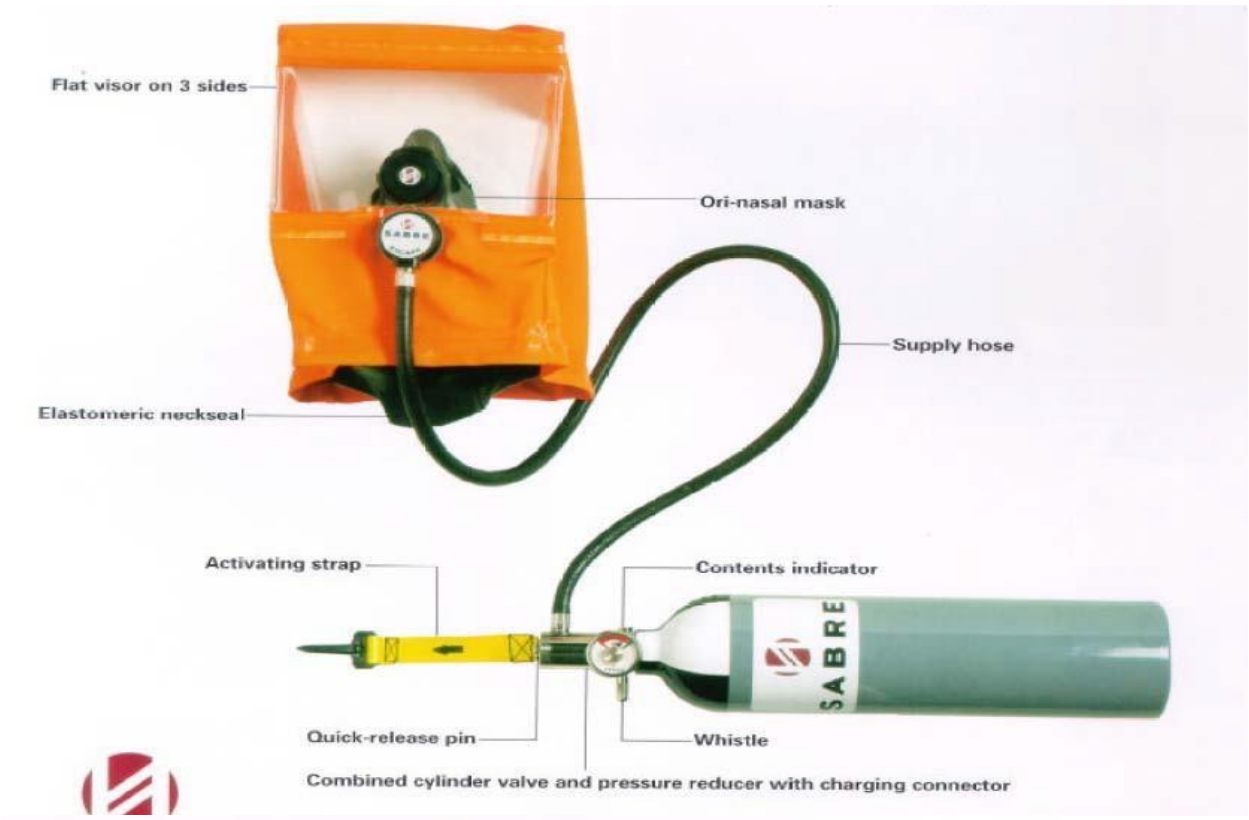
The EEBD shall include a hood or full face piece, as appropriate, to protect the eyes, nose and mouth during escape. Hoods and face pieces shall be constructed of flame resistant materials and include a clear window for viewing.

An EEBD, when stored, shall be suitably protected from the environment.

Brief instructions or diagrams clearly illustrating their use shall be clearly printed on the EEBD. The donning procedures shall be quick and easy to allow for situations where there is little time to seek safety from a hazardous atmosphere.

The EEBD carried onboard are manufactured by Sabre. See the diagram below which shows an EEBD in use.

Below, is diagram labelling all the important parts of the SABRE EEBD



Instant action

The constant flow of air is automatically activated on opening the bag. A quick release pin is fitted to the pressure reducing valve and attached to bag via a strap. The action of opening the bag pulls the strap – thus releasing the pin.

Pneumatic system

The combined cylinder and pressure reducing valve is fitted to the cylinder and features a spring and piston mechanism with fixed orifice outlet. The valve incorporates a pressure indicator and warning whistle which sounds when the designed duration is reached. A pressure relief valve protects the system from over pressurization.

Air hood

The air hood utilizes a unique cubed design for optimum comfort and visibility. The hood can be easily flat-packed for stowage with-out creasing the visor whilst allowing rapid removal from the bag for easy donning. The hood is fabricated from PVC coated materials with an ozone resistant elastomeric neck seal. An inner mask prevents visor misting and minimizes CO2 dead space.

The EEBD Bag

The bag allows for quick donning, and can be comfortably carried. Velcro strips secure the opening with tamperproof tags supplied to prevent unauthorized access. A transparent window is provided to allow the cylinder contents gauge and activation pin to be inspected without opening the bag. The bag also features an adjustable webbing strap with dual point fixing, for versatility.

How to use the EEBD

1. Check the pressure on the pressure gauge. Observe the cylinder capacity and pull apart the seal.

2. Put on the bag as shown in the image.

3. Take out the face mask rapidly and wear it form the head down. Make sure the transparent window is in the front and the shawl reaches the shoulders.

4. Quickly evacuate from the scene of the accident/emergency.

Technical data

Cylinder working pressure:	210 bar
Cylinder capacity:	3 liter
Weight:	6 kg
Duration:	15 minutes

Article number	Description	Dimensions	Weight
EEBD15	EEBD	530 x 250 x 150 mm	6 kg
EEBDC	EEBD cabinet	762x 282 x 211 mm	4 kg

Inspections and Maintenance

Regular maintenance of the escape breathing device is crucial for its optimal performance. It is recommended to conduct checks at least quarterly during spare time.

Daily Inspections
Thoroughly inspect all components of the emergency escape breathing device for any signs of damage. Monitor the pressure gauge readings to ensure that the air pressure inside the cylinder remains at or above 210 bar (at 20 degrees celcius). If the pressure falls below 210 bar, the cylinder needs recharging; however, it should not exceed the rated pressure value.

Note: Variations in air pressure due to thermal expansion and contraction are normal with changes in environmental temperature. Low or high temperatures may cause fluctuations in pressure. At a room temperature of 20 degrees celcius, the recommended air pressure inside the device is 210 bar. The corresponding relationship between temperature and pressure is outlined in Table 2.

Temperature	Pressure Inside the Cylinder (Bar)	Temperature	Pressure Inside the Cylinder (Bar)
-30 0C	160	20 0C	210
-20 0C	170	30 0C	220
-10 0C	180	40 0C	230
0 0C	190	50 0C	240
10 0C	200	60 0C	250

Cylinder

a. Avoid collision, scratch and pound; avoid high-temperature baking, freezing, and sun exposure; repair peeling paint and prevent sidewall rust;
b. Use it according to date marked; do pressure test once every three years and be qualified before use;
c. Inflate timely after use for next use;

Decompression device
Do not disassembly during use. Once repairing, re-adjust the device.

Notes

1. The device should be placed in a dry, clear, easy-to-access place where there is no direct sunshine;
2. The device should not come close to any grease or other corrosive liquid;
3. The cylinder should do pressure test once every three years in manufacturer or government authority and be qualified before use;
4. The device should avoid heavy pressing, high-temperature baking, freezing and sun exposure;
5. Train relevant personnel before using the device;
6. Once there is failure or damaged parts, repair them in manufacturer or its authorized agencies;
7. No filling oxygen to the cylinder to avoid accidents;
8. Inflate the cylinder to 210 bar first and after cooling, re-inflate to 210 bar to ensure use time;

9. Compressed air for breathing should be clean, free of odor and meet the following requirements:
   CO no more than 5.5 mg/m
   CO_2 no more than 900 mg/m
   Oil no more than 0.5 mg/m
   Water no more than 50 mg/m

10. The device should not be used for fire-fighting, into a hypoxia empty tank or liquid cargo, or for fire fighters;
11. No take off the hood before the cylinder valve pin is not pulled;
12. If need to take off the hood to check, please be sure to separate the connection hook from hood. After checking, please reconnect the hook with hood.

Fault diagnosis and solutions

Faults	Causes	Solutions
Air leakage at cylinder valve	Valve disc rupture, pressure cap screw loose, O-ring aging	Replace disc, tighten pressure cap, replace O-ring
No indication on pressure gauge	Pressure gauge damaged, leaking air hose block or air leaking	Replace gauge or air hose
Air leakage at connection parts	O-ring aging or damaged	Replace new O-ring
Damage on face mask and bag	Aging or damaged	Replace new face mask and bag

Complete set of Escape device

Complete sets include:
1. Escape device one set
2. Device bag one piece
3. Device packing carton one piece
3. Attachment papers one set

Transportation and Storage

No rain exposure, do not put in carriage with oil, flammable, corrosive media. Handle gently; Place the device in a dry, clean, and easy-to-access location where the relative humidity is less than 80%, away from the heat. Avoid sun exposure.

Warranty and maintenance

The escape device (EEBD) is within warranty of six months from leaving the factory; if exceeding six months, maintenance costs are responsible for the user; users should do the repair in the manufacturer or authority approved repair station;

The user should check the escape device (EEBD) periodically, to establish if any problems occur. If so, the user should solve them in time. When replacing pressure gauge, do the following:

a. Open the EEBD cylinder valve pin, clear the air inside the cylinder;
b. Use a wrench to remove the pressure gauge;
c. Replace a new one, and tighten it;
d. Use air compressor or charging unit, please be sure that the air compressor is up to 200bar, then open the valve hand wheel to charge, fill in the gas to 210bar (20 degrees Celsius) first, and after cooling, re-filling the gas to 210;
e. Put the cylinders into water to check the air tightness;
f. Connected the qualified cylinders with medium-pressure air hose, connect the hood with cylinder valve pin, and then put the whole set EEBD into bag

18. Fixed CO2 Fire extinguishing system

Fixed CO2 fire extinguishing systems are used to protect large risk areas such as machinery spaces and cargo holds and small specific risks such as paint stores and galley exhaust ducts.

Advantages of CO2

- Naturally occurring gas
- Zero Ozone Depletion Potential
- Low agent cost
- Established technology
- Effective on deep seated fires
- No thermal breakdown products
- Safe for use on live electrical equipment

Disadvantages

- Health & Safety: Cannot be used under automatic control in manned areas
- Global Warming Potential
- Atmospheric lifetime
- High pressure storage (57.2 bars at 20C)
- High concentrations are required to effect extinguishing. As a result, large numbers of cylinders are required, making it unsuitable for use where space and weight are important considerations
- Limited range of cylinder sizes

CO2 is clean

CO2 is a colorless, odorless, dry, inert gas and is a naturally occurring gas. After extinguishing a fire it vaporizes fully leaving no residue. There is no mess, nothing to clear up, no water damage. It is non corrosive and will not contaminate foodstuffs. It is non- conductive and so can be used on electrical equipment. It is safely used to protect delicate electrical equipment, antiquities or archive materials.

CO2 is versatile

With the versatility of electrical, pneumatic or mechanical actuation, CO2 systems can be designed to suit any fire hazard, which is why it has been successfully used in a variety of applications including Transformer stations, Paint spray booths, Flammable liquid storage areas, Printing presses and other process machinery, Floor voids, Turbines and generators as well as numerous marine applications. CO2 flooding is not advisable in accommodation areas as it is toxic at the concentrations required to extinguish fire.

CO2 is cost effective

Carbon dioxide is a naturally occurring gas and a standard commercial product with many other uses and it is readily available throughout the world. It can be obtained cheaply and this is an important consideration when frequent recharging of storage containers is necessary.

The system consists of a high-pressure cylinder bank with either manual or pressure operated cylinder top valves. The cylinder bank and a unique manifold are stored in their own insulated room. Valves are connected to the manifold using flexible high-pressure hoses. The manifold incorporates a non-return valve at each cylinder connection so that any cylinder may be disconnected without impairing the integrity of the system and so when the gas is released it will not feed back into empty cylinders.

Other components that are found on the system includes a pressure relief valve vented to the atmosphere, a pressure switch to activate a audible warning of gas pressure on the manifold and shut down ventilation fans, an airline connection for checking that the lines and nozzles are clear.

From main distribution valves, a piping system is used to distribute the gas to the discharge nozzles which are placed uniformly throughout the protected spaces.

The system is operated manually from a release cabinet located centrally, or from release cabinets placed close to the protected space.

When releasing the system, the main distribution valve opens while simultaneously the pilot gas to the pressure operated CO2 cylinder top valves is delayed for a specified time. After the delay, the cylinder top valves open and the gas is discharged through the piping and nozzles into the protected space.

Basic steps for the operation of the system include

1. Make certain that crewmembers have evacuated the space
2. Turn off power to fans
3. Close all opening to space: doors, hatches, vents etc
4. Operate release valve as per operator's instructions. As

per SOLAS chapter II

Gas cylinders should be constructed in accordance with current British standards, which require inter alia the tare weight and the water capacity to be stamped on it.

The weight of CO2 permitted in each cylinder should not exceed two-thirds of a kilogram for every litre of water capacity of the cylinder at 15ºC. Each cylinder head discharge valve assembly must be fitted with a bursting disc guaranteed to rupture at a pressure of between 177 and 193 bar. The arrangements should permit the free escape of gas from a cylinder when the bursting disc is ruptured but non-return valves should be provided in the discharge system to allow any cylinder or flexible discharge pipe to be disconnected without affecting the use of other cylinders in the system and to prevent any discharge to the CO2 cylinder storage room when the system is put into operation to smother a fire. Cylinder head discharge valves, if arranged for remote release should be capable of being opened manually in the event of malfunction of the remote release system.

The Carbon Dioxide storage rooms should provide access from the open deck in an emergency for personnel wearing breathing apparatus, be well illuminated, dry and well ventilated and there should be no risk to personnel from leakage or from bursting disc rupture. The storage rooms should not be accessible directly from boiler, machinery, accommodation or cargo spaces. The space should be reserved solely for the purpose of the CO2 fire extinguishing system. The ambient temperature should not exceed 60ºC and where adjacent spaces are likely to be at higher temperatures, special precautions such as insulation of boundaries or power assisted ventilation should be provided to prevent the overheating.

Suitable means should be provided for the cylinders to be weighed as necessary. Attention is drawn to the inability of liquid level detectors to operate satisfactorily when the ambient temperature is near or above the critical temperature which for CO^2 is 30.5ºC. The space should permit inspection, testing, maintenance and operation of the system to be carried out easily and safely.

The distribution valves should be of quick opening type to avoid wire drawing and consequent freezing. All power and automatically operated valves should be capable of being manually controlled from a local position in case of malfunction.

Where gas pressure from pilot cylinders is used as a means of releasing the remaining cylinders at least two such cylinders should be used simultaneously for such operation. Effective safeguards should be provided against the gas being accidentally released when a CO2 system is being serviced on board and to guard against the inadvertent, and as far as practicable, the malicious use of the controls after the system has been installed or serviced. To achieve this, the discharge of CO2 from the storage cylinders should be isolated from the machinery space by means of a sector valve and so arranged that the control cabinet door cannot be closed unless the sector valve is in the fully closed position. In installations where the sector valves are gas operated equivalent means of safeguarding the system against inadvertent discharge should be provided on the actuation position. The release arrangements should give an indication if the system has been operated. Automatic time delays should not be incorporated in any of the release arrangements for the system. Distribution piping systems should be of a permanent character and arranged so that CO2 is effectively distributed throughout the protected spaces through suitably designed nozzles. The arrangements should be such that part of the charge is distributed below the floor plates and over the tank top.

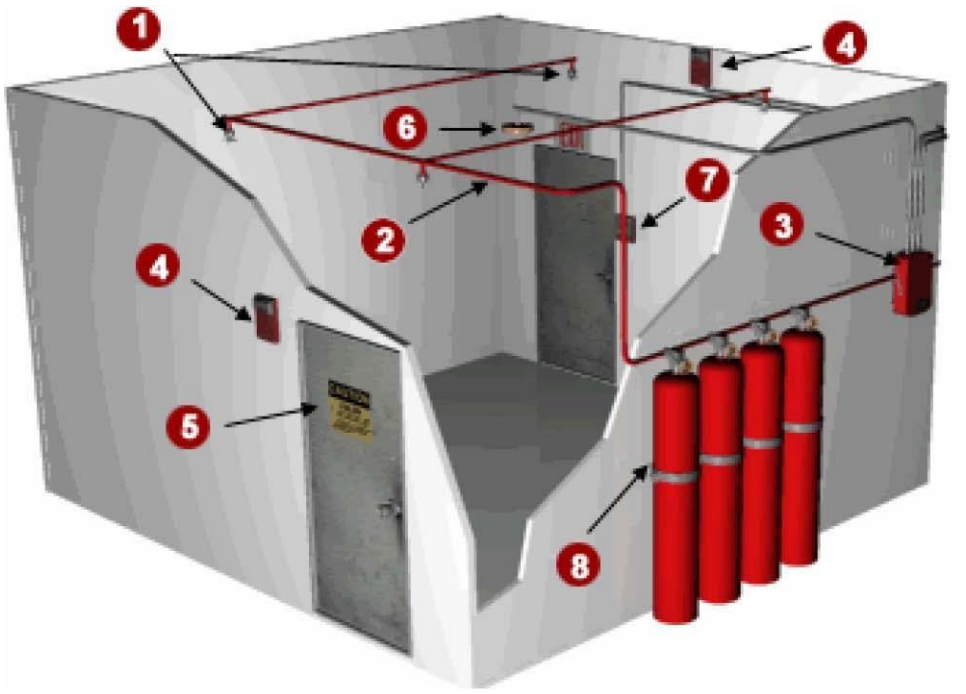
The Regulations require that 85% of the required concentrations for machinery spaces and cargo pump rooms is achieved in such spaces within two minutes. However the arrangements should additionally provide for a discharge of at least 50% of the required amount of gas in the first minute of operation.

The suppliers should confirm that all CO2 pipes used within the machinery space have been tested to 122 bar; and the surveyor should satisfy himself, e.g. by testing a sample joint to 122 bar or by other means, that the jointing arrangements are sufficient for the intended service.

Instructions for operating the installation must be displayed near the remote operating controls, distribution control valves and also near the gas cylinders. Such instructions should state that when the remote release controls are used, the cylinder storage room should be checked to confirm that the medium has been discharged. When the installation is used to protect the pump room or cargo tanks of a tanker and similar spaces, a notice should be displayed indicating that the system should not be used for inerting purposes unless the compartment is gas free since the injection of CO^2 may generate a static charge capable of igniting flammable atmospheres.

When the means for putting the system into operation are located within a compartment which may be locked, e.g. the CO2 cylinder room, one key to such a compartment should be provided adjacent to the entrance in a suitably marked glass-fronted box. Normally, mechanical ventilation of the protected space should be capable of being shut down manually. Where this is achieved automatically on release of CO2, override facilities that can be rapidly operated without entry into the protected space should be provided to enable spaces to be ventilated after the injection of CO2. Suitable notices should be posted by the ventilation system controls to indicate that provisions for automatic ventilation shut down have

been fitted and where these are located. Notices should be posted on the entrances to every space protected by CO2 indicating that the space is so protected and that personnel should evacuate the space immediately on hearing the CO2 alarm.
The means provided for giving audible alarm should be distinct from all other alarms. When such means are electric, the power should be obtained from the emergency source batteries or through the emergency switchboard. Supplies for air operated devices should be taken from the main air receivers through a safeguarded supply system. When fitted in pump rooms, such alarms if electric should be intrinsically safe and if of the air operated
type should be connected to a safeguarded moisture free supply. The arrangements should be such that the alarm is given automatically before the release of CO^2. Interlocks or time delays to delay operation of the release mechanisms are not acceptable.
Below is a diagram showing the components of what a fixed CO2 system looks like fore a small space such as a paint locker



System Components

1. Discharge nozzles
2. Piping
3. Control panel
4. Discharge or warning alarm(s)
5. Hazard warning or caution signs
6. Automatic fire detection devices(s)
7. Manual discharge station(s)
8. Storage container(s) & extinguishing agent

Please refer to section F for ship specific details regarding all CO2 fixed fire fighting installations onboard.

19. Fixed Foam Fire extinguishing system

Deck foam systems for tankers

1. Capable of delivering foam to the entire cargo tank deck as well as into a cargo tank if it is ruptured.

2. Control station outside and away from cargo area and readily accessible, simple and rapid operation.

3. Rate of foam not less than 0.6 litres/ m2/ minute.

4. Sufficient supply of foam concentrates to produce foam for at least 20 minutes. (IG system fitted)

5. Foam supplied through foam monitors and applicators. (1250 litre/min)

6. Capacity of any monitors at least 3 liter/m2/minute.

7. Capacity of the applicator is for not less than 400 litres/minute, and throw not less than 15 meter.

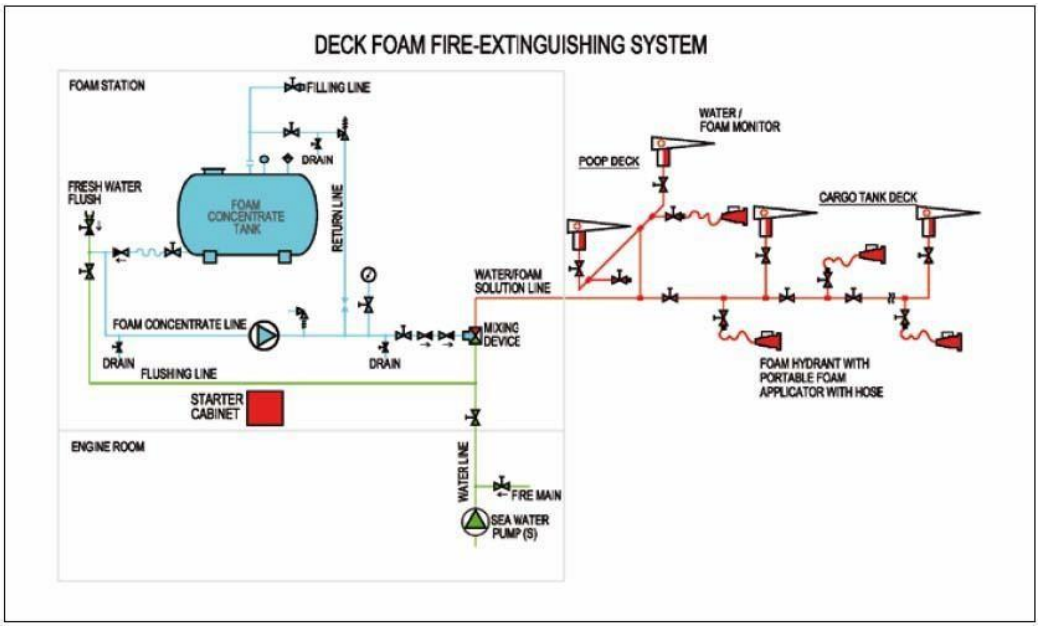
Description

The system is comprised of the following components:

- Foam tank
- Fire water pump
- Foam liquid pump
- Foam proportioner
- Distribution valves and piping
- Foam monitors / Hoses

Below is an example of a deck foam fire – extinguishing system

The concentrate is contained within a tank and usually introduced into the system by means of a foam pump and venturi proportioner. Water is pumped through the proportioner which contains a venturi restriction. The pressure drop caused by the venturi draws the correct amount of foam compound into the system. The water and foam compound is termed foam solution. At the discharge monitor or branch pipe or nozzles air is entrained to expand the solution into foam.



The cargo deck is normally provided with monitors situated along the centreline. Vessels with stern and bow loading / discharging arrangements are to have suitable foam protection in those areas. Each monitor will be provided with an isolating valve and in the foam main line immediately forward of each monitor there will be a valve to isolate damaged sections of the main.

Foam monitors are manually operated by a lever or geared hand wheel. Cross winds significantly affect the effective range of a foam monitor. Some tests indicate that in a crosswind of 30 knots the effective range of a deck monitor was reduced to a third of that achieved in still conditions. Other tests show that cross winds of only 10 knots greatly affect the throw of a monitor.

20. Fixed Dry Power extinguishing system

Vessels carrying liquefied gases in bulk must be provided with a dry chemical powder system for fire protection of the cargo deck area and any bow and stern loading areas. It must be possible to deliver powder to any part of the cargo deck from at least two monitors. An inert gas usually nitrogen, stored in pressurized cylinders is used to pressurise the cylinders.

A monitor is required to protect the areas around the loading and discharge manifolds. It must be capable of being operated locally and remotely, although remote aiming is not required if the entire area is covered from its fixed position. At least one hand hose line and pistol or monitor should be situated at the after end of the cargo area. All hand held line and monitors should be capable of actuation at the hose storage reel or monitor.
The minimum permitted discharge rate for monitors is 10 kg/second and for hand hoses 3.5kg/second. The required capacity is increased with the distance each monitor is required to cover

Capacity (Kg/second)	10	25	45
Maximum distance of coverage (m)	10	30	40

Each container is to have sufficient powder to provide 45 seconds of discharge for all monitors and hand hoses fed by it.

An example of a dry power pressure vessel

System operation:

Nitrogen passing through a reduction valve pressurises the tank and nozzles fitted in the bottom atomise the contents.

When the current pressure has been achieved, a pilot valve opens the main discharge valve and the dry powder flows through the distribution manifold to the monitor or hand hose line in question.

The pressure during discharge is kept constant by means of a reduction valve placed upstream of the dry powder unit.

Release of the system may be remotely operated from the release boxes utilising a nitrogen pilot cylinder or alternatively manually operated at the dry powder unit.

The propellant gas system is designed to contain sufficient nitrogen to maintain the pressure during release as well as to clean the pipes and hand hose lines after discharge.

The hand hose line cabinet are mounted in a GRP/FRP box suitable for installation on the weather deck and fitted with a release arrangement, trigger nozzle, and flange connection for the supply pipe.

Monitors are located to ensure coverage of the cargo manifolds on each side of the vessel. Before operating the system from a hose line cabinet, ensure that all of the hose has been pulled from the cabinet and the discharge pistol is held correctly.

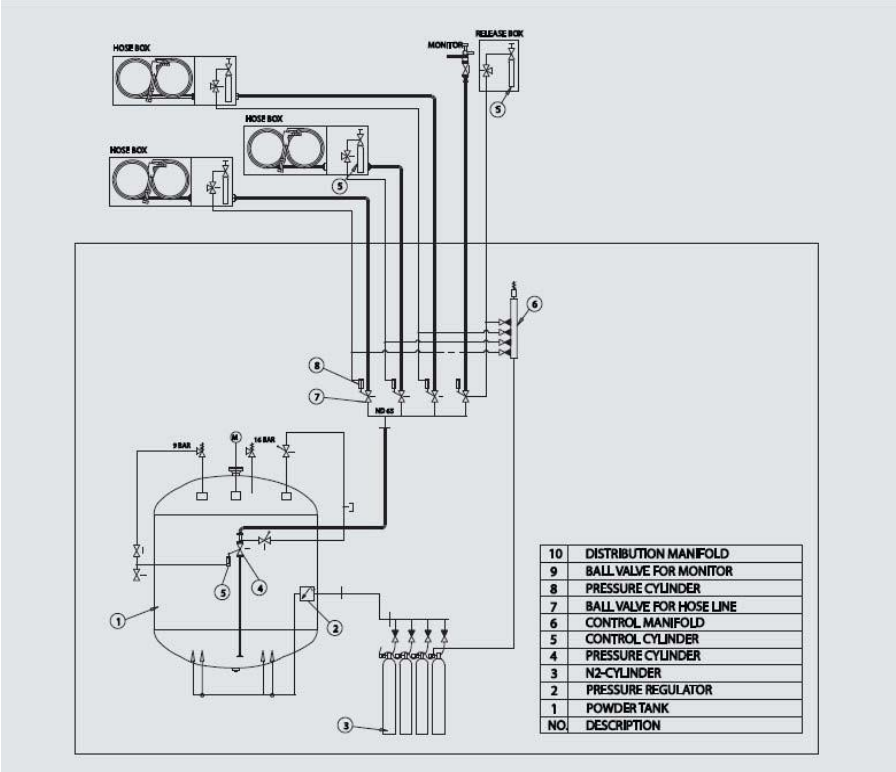
The system can normally be activated from the following locations

- Cargo Control Room
- Fire Control Centre
- Dry Powder Rooms
- At the Hand line units

Caution

Ensure dry power rooms are well ventilated prior to entry, particularly after activation of the system.
Below is a line diagram of how a dry power system operates.

Refer to manufactures instructions for further information of the system fitted to your vessel.



Maintenance

In general, all dry chemical powder systems should be thoroughly inspected and checked annually by a competent person.

The inspection and maintenance of hand hose line systems will vary with the location and climate conditions.
Dry chemical powder is available in various sized packages. Whatever the container, it should be kept tightly closed and stored in a dry location in order to prevent absorption of moisture. Once the powder has lost its free flowing characteristic, it shall be discharged.

Monitors should be free to move at all times.

21. Deluge system

Deluge systems are similar to sprinkler systems except the pipes terminate at open nozzles. In an event of a fire the nozzles distribute large quantities of water over the entire protected area. The water application is uniformly distributed throughout the risk area. Below is a deluge nozzle.

The water deluge system is used for cooling, fire protection and crew protection and is installed to cover

1. Exposed cargo tank domes and exposed cargo areas

2. Exposed on deck flammable or toxic product storage containers

3. Cargo discharge manifolds and the area of their control valves and area of other control valves

4. Boundaries of the following

    - Superstructure and deckhouses normally manned
    - Cargo compressor rooms
    - Storerooms containing high risk fire items
    - Cargo control rooms
    - Lifeboat embarkation areas

The systems on ships carrying liquefied gases in bulk is to uniformly distribute water spray on horizontal surfaces at a rate of at least 10 l/m2 per minute, and on vertical surfaces at

rate of at least 4 l/m2 . The system may comprise of two or more completely independent sections or it must be provided with valves for isolating damaged sections.

Sea water is normally supplied by the educator drive & water spray pump. This pump may be started locally or remotely from the following locations. These locations may change depending on the class of vessel:

- The integrated automation system (IAS)
- Wheelhouse
- Engine room control room
- Cargo control room
- Fire control centre

Both suction and discharge valves should normally be left open in order that if required, the water spray can be commenced by starting the pump.

In most systems, in the event of a failure of the eductor drive & water spray pump, the deck water spray system can be provided with a limited supply by the bilge & general service pump, the fire bilge and general service pump or the fire pump via the operation of cross over valves. These pumps may not reach the total system demand.

All steel pipes are normally internally lined with polyethylene and the larger diameter ones are lined with neoprene.

On normal operation of the system you must check

- Suction and discharge valves remain open (these should always be open)
- Check that any crossover valves between the water spray pump and any other pumps are closed
- Check that system drain lines are closed
- Check that the educator drive and water spray pump is free to rotate
- Close fire, bilge & general service pump, and bilge & general service non-return valves on discharge to water spray.

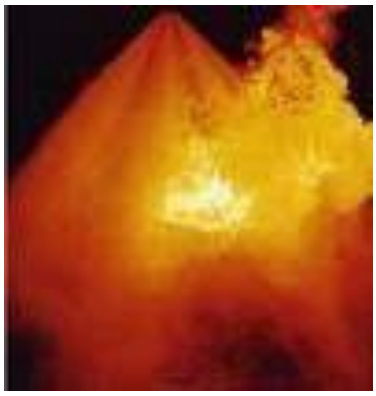
The pump should now be ready to operate.

22. **Water Mist Systems**

The water works on the principle that the atomization of the water increases its surface area and effectively extinguishes the fire by a combination of cooling and smothering. Due to this large increase in effective surface area, only a small quantity of water is required.

Advantages of a water mist systems are as follows
Minimal fire smoke and water damage
Favourable lifetime costs
Flexible installation with minimal disruption
Minimal space requirements
Minimal weight
Safe for people, the environment and property
Smaller pipe sizes

Conventional low pressure water spray or sprinkler systems can cause considerable water damage. Often the water damage is greater than the fire damage. Low pressure systems can be difficult to install.
Below is a compartment in which the water mist system has been activated.



Water has two main fire fighting mechanisms, both related to the evaporation of water:

Cooling

When turning into vapour, water absorbs more heat than any other fire fighting agent

Inerting

As it evaporates the water volume expands over 1,700 times, displacing oxygen. The evaporation rate of water depends on the free surface area. The free surface area can be increased by splitting the bulk volume into droplets: the smaller the droplets, the faster the evaporation and the more efficient the cooling and inerting.

Water in the form of mist has an additional fire fighting mechanism that no other agent has:

Blocking of radiant heat

A dense cloud of small water droplets absorbs and scatters heat radiation.
The droplet size has a considerable impact on the surface area and the number of droplets as illustrated in the following table describing the properties of one litre of water:

	Droplet diameter (mm)	No of droplets	Surface area (m^2)
Conventional sprinklers	10	1.9×10^3	0.6
Low pressure mist	1 0.1	1.9×10^6 1.9×10^9	6 60
HI-Fog	0.01	1.9×10^{12}	600
	0.1 X	1000 X	10 X

Decreasing the droplet size by a factor of ten increases the surface area (and evaporation rate) by a factor of ten and the number of droplets by a factor of a thousand! So a lot less water is needed for the same cooling and inerting efficiency than in conventional water spray systems. And in addition, the surroundings are protected against radiant heat.

Droplet size alone does not guarantee efficient fire fighting: Water also needs to reach the flames, i.e. it needs to penetrate the upward draughts produced by the fire.

The fire fighting capabilities of a water mist system are defined by i.
droplet size distribution,
ii. number of droplets and
iii. Penetration.

The combination of these properties is entirely system-specific. HI-FOG water mist (Which can be found on many of our vessels is an example of one such system)

HI-FOG systems are unique water mist systems, and their capabilities cannot be generalized to any other water mist system.

HI-FOG water mist is always generated by a high pressure. The systems are powered by constant pressure electric or diesel pumps (pressures up to 140 bar) or by pressurized gas cylinders (pressures up to 200 bar). Drop sizes usually fall in the range below 200 µm. The penetration distance may be up to 7 - 8 m horizontally, and even longer vertically. The good penetration also contributes to distributing the mist throughout the space, even past obstacles. The HI-FOG water mist behaves almost like a gas

HI-FOG systems have a high cooling, inerting and radiant heat blocking efficiency. Gas temperatures around the fire drop abruptly within seconds after discharge, and the fire is quickly surrounded by a dense cloud of small droplets. The radiant heat is blocked so effectively that even a few meters from the fire people do not feel any heat. Adjacent structures are well protected, even when the fire is still burning.

Water mist systems have to be carefully designed, give even coverage of the protected area and, when protecting a specific item, arranged so as to be as close as possible to the risk. Areas fitted with water spray coverage are often machinery spaces. The activation is either automatic or manual.

Sprinkler heads

The sprinkler consists of the sprinkler body, spool valve, micro nozzles and a heat sensitive glass bulb. In case of fire the heat sensitive glass bulb will burst at a given temperature. This releases the spool valve and the high pressure water is released though the sprinkler. The sprinklers are made of brass and are normally chrome or nickel plated.

Piping

The water mist system utilises small bore stainless steel pipes. The pipe connections are usually made with compression fittings, cutting rings or by welding.

Power units

We will look at two types of power units in more detail, starting with a diesel driven pump.

This type of power unit can be used if electric power is not available. The unit is compact and self contained.

Gas driven pump

This is a self contained pump unit. No electric or other external power source is required for the operation of the pump. The feed water can be taken either from a pressurised water system or from a feed water system. The unit consists of a gas driven mechanical piston type pump. The gas can either be pressurised air or nitrogen depending on the application. The amount of gas required depends on the size of the area to be protected and the required protection time

There are many other power units available please consult manufacturers guidelines.

23. Fire Detection & Alarm system

A fire detection system is designed to detect rapidly the onset of fire, give early warning of the situation and so provide the crew with the best possible chance of controlling and extinguishing the fire. The system may comprise of the following components:

- Central Control and monitoring panel
- Repeater panels
- Combination of heat, smoke and flame detectors
- Alarm call points
- Audible alarms

There are to be at least two separate power sources, one of which is taken from the emergency supply. The system is to be operable at all times, with the power supplies and electric circuits continuously monitored for failure or fault.

Detectors and manually operated call-points are grouped in sections and activation of any unit initiates an audible and visual alarm at the control panel and repeater units and an audible alarm will be audible alarm will be activated throughout the crew accommodation, control stations and main machinery spaces. The control is normally located on the bridge or in the fire control centre.

Ships built after July 1986

The indicating units shall at least show the section in which a detector or call-point has operated. At least one indicating unit is to be easily accessible at all times at sea or in port. If the control panel is located in the fire control station there shall be an indicating panel on the bridge.

Systems fitted after October 1994

Systems with zone address identification are to be arranged so that:

- A loop cannot be damaged at more than one point by a fire
- A fault (Loss of power, short circuit, earth, etc) will not render the whole loop ineffective
- The configuration of the system can be restored in the event of failure (electric, electronic, information)
- The first initiated fire alarm will not prevent any other detector from initiating further alarms.

Types of detectors

Heat detectors

A heat detector is a device that detects heat and can be either electrical or mechanical in operation. The most common types are thermocouple and the electro – Pneumatic, both respond to changes in ambient temperature. Typically, if the ambient temperature rises above a predetermined threshold, then an alarm signal is triggered. The most common predetermined value is between 54oC and 78 oC. Detectors with a higher temperature rating may be used in areas of high ambient temperature such as a galley, although the permissible operating temperature must not be more than 30 oC above ambient.

Optical smoke detectors

Use a light source to determine obscuration or light scatter caused by smoke particles entering the chamber. More advanced units may use laser technology.

ionization smoke detectors

Sense, at an early stage, the invisible smoke particles evolved from a fire.

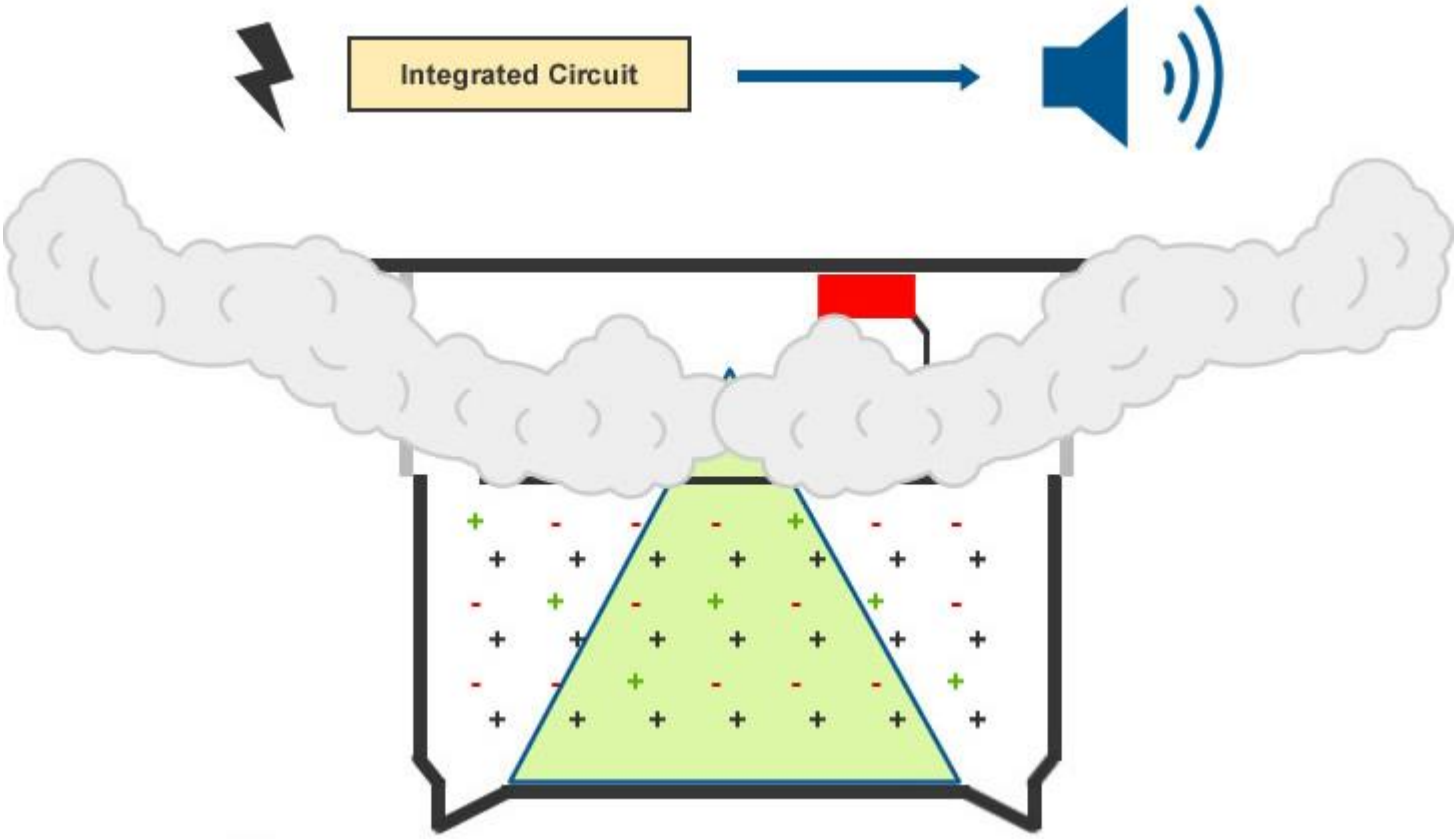
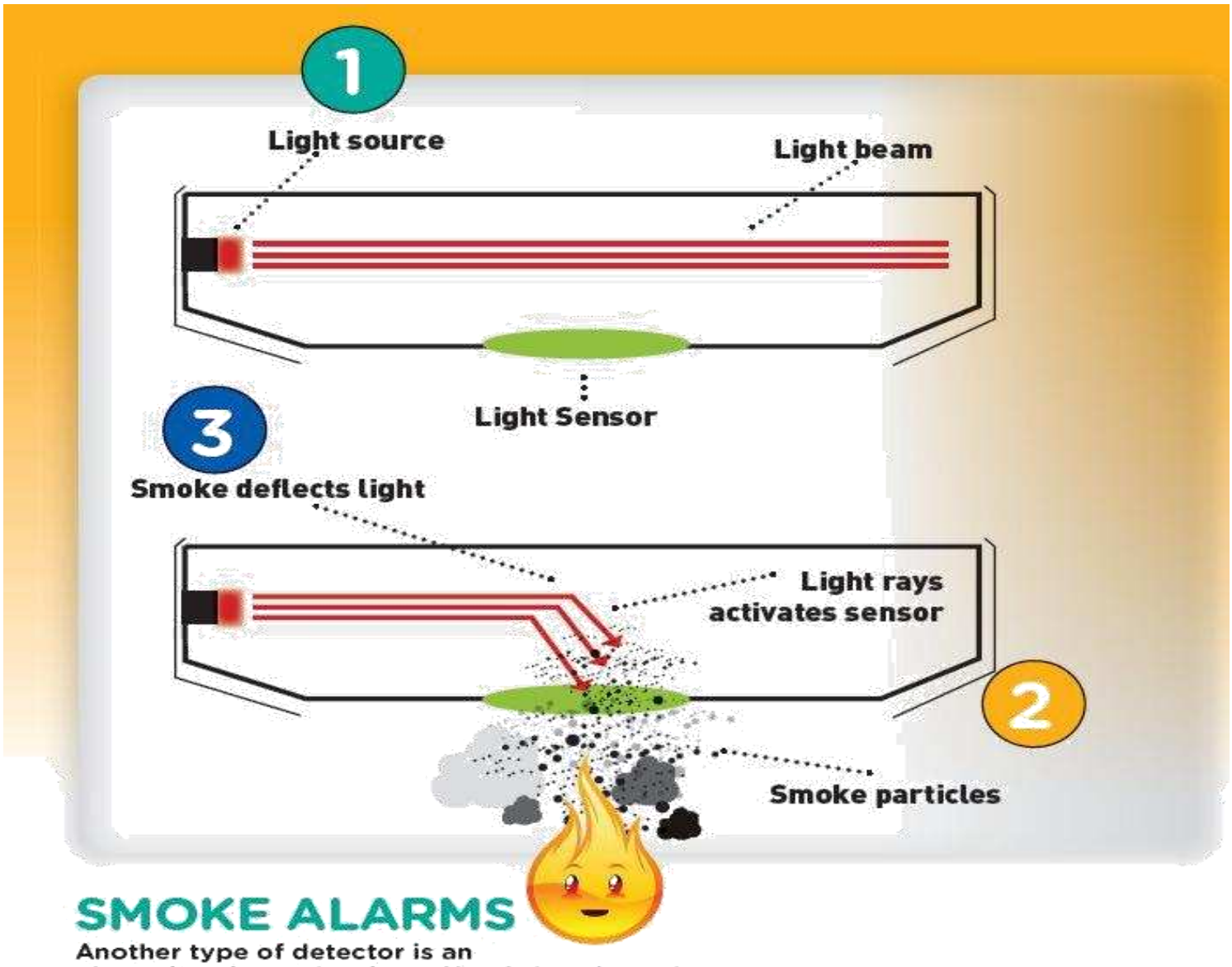


Photo thermal detectors

This type of detector the status of the optical (smoke detecting) chamber is monitored and compared with the heat sensing element. The alarm signal is sent when the comparison indicates a fire situation. The system is able to discriminate between smoke from fires and smoke from other sources such as cigarettes or steam and reduces the incidents of false alarms.



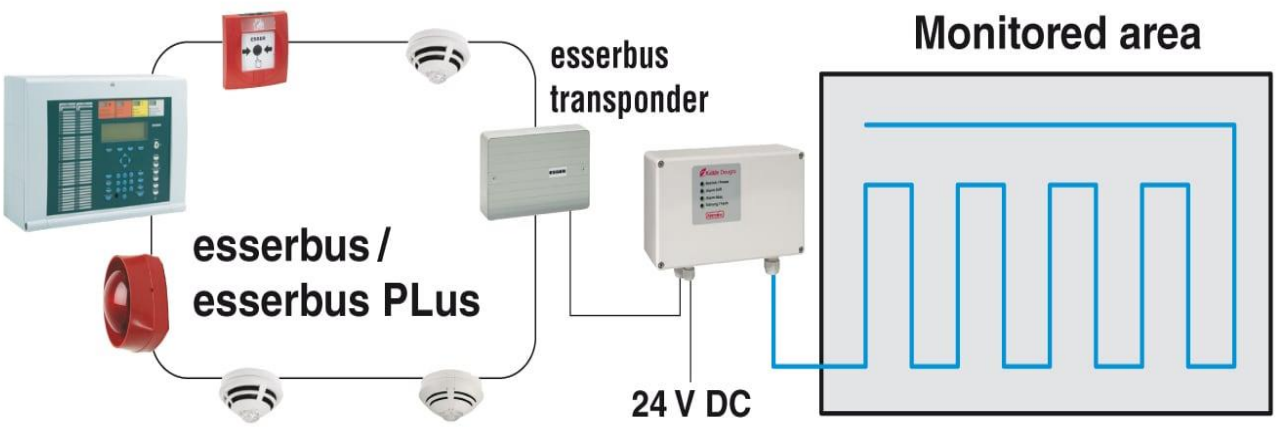
Flame detector

The infrared and ultraviolet bands of the electromagnetic spectrum may be used for flame detection, more commonly the infrared flame detector is found onboard. Infrared red (IR) flame detectors respond to electromagnetic radiation resulting from the burning of carbon and hydrocarbon materials and to the flame flicker frequencies. The units should be immune to false alarms caused by solar rays

Linear heat detectors

Types of line heat detectors include pressurized tubing, cables that contain dielectric materials, fibre optic cables and other systems. Linear heat detection may be found on cable trays and in environments where smoke detection would not be suitable.

Fixed fire detection and fire alarm system installations shall be suitable for the nature of the space, fire growth potential and potential generation of smoke and gases.



Protection of machinery spaces

A fixed fire detection and alarm system shall be installed in:

Periodically unattended machinery spaces; and

Machinery spaces where: the installation of automatic and remote control systems and equipment has been approved in lieu of continuous manning of the space; and the main propulsion and associated machinery including sources of the main sources of electrical power, are provided with various degrees of automatic or remote control and are under continuous manned supervision from a control room.

The fixed fire detection and fire system used in a machinery space shall be so designed and the detectors so positioned as to detect rapidly the onset of fire in any part of those spaces and under any normal conditions of operation of the machinery and variations of ventilation as required by the possible range of ambient temperatures.

Manual operated call points

Manually operated call points shall be installed throughout the accommodation spaces, service spaces and control stations. One manually operated call point shall be located at each exit. Manually operated call points shall be readily accessible in the corridors of each deck such that no part of the corridor is more than 20m from a manually operated call point.

Section D

24. Fire Doors

In order to restrict the spread of fire the bulkheads and decks of a vessel are constructed to a particular standard. Various standards apply depending on the type of vessel and the nature of the space surrounded. Generally the fire resistance of a bulkhead is expressed as A, B or C followed by a number indicating the time that the division will prevent a specified temperature rise.

Class 'A'

A division constructed of steel or equivalent material and capable of preventing the passage of smoke or flame for one hour. Class 'A' division bulkheads should be insulated with non-combustible materials so that on the side opposite to the fire the average temperature will not rise more than 139 degrees C above the original temperature, nor more than 180 degrees C at any one point.

Class 'A-60' -Must prevent the stated temperature rise for at least 60 minutes.
Class 'A-30' -Must prevent the stated temperature rise for at least 30 minutes.
Class 'A-15' -Must prevent the stated temperature rise for at least 15 minutes.
Class 'A-0' - Must prevent the stated temperature rise for at least 0minutes.

Class 'B'

A division capable of preventing the passage of flame for the first half an hour of the standard test. The insulation should be such that on the side opposite to a fire the average temperature will not rise more than 139 degrees C above the original temperature, nor more then 225 degrees C at any one point

Class 'B-15' -Must prevent the stated temperature rise for at least 15 minutes.
Class 'B-0' - Must prevent the stated temperature rise for at least 0minutes.

A class 'B' division must be constructed of approved non-combustible material except that combustible materials may be permitted provided they meet certain other requirements.

Class 'C'

These divisions are constructed of approved non combustible materials. They do not need to meet the requirements for limiting the passage of smoke and flame nor limitations relative to temperature rise.

Combustible veneers are permitted provided they meet other requirements.

Water tight doors are not required to be insulated

Doors in fire-resisting divisions in cargo ships

The fire resistance of doors shall be equivalent to that of the division in which they are fitted, this being determined in accordance with the Fire Test Procedures Code.

Doors and door frames in "A" class divisions shall be constructed of steel. Doors in "B" class divisions shall be non combustible. Doors fitted in boundary bulkheads of machinery spaces of category A shall be reasonably gastight and self-closing.

6751
A class division

6752
B class division

6753
Main vertical zone division

6754
A class fire door

6755
A class watertight fire door

6756
A class semi-watertight fire door

6757
B class fire door

6758
B class watertight fire door

6759
B class semi-watertight fire door

6760
A class self closing fire door

6761
A class self closing watertight fire door

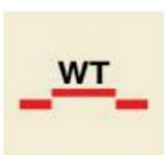
6762
A class self closing semi-watertight fire door

6763
B class self closing fire door

6764
B class self closing watertight fire door

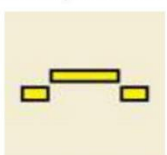
6765
B class self closing semi-watertight fire door

6766
A class sliding fire door

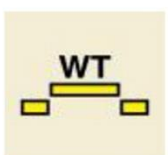


6767
A class watertight sliding fire door

6768
A class semi-watertight sliding fire door



6769
B class sliding fire door



6770
B class watertight sliding fire door

Doors required to be self closing shall not be fitted with hold-back hooks. However, hold-back arrangements fitted with remote release devices of the fail safe type may be utilized. In corridor bulkheads, ventilation openings may be permitted in and under the doors of cabins and public spaces. Ventilation openings are also permitted in "B" class doors leading to lavatories, offices, pantries, lockers and store-rooms. Except as permitted below, the openings shall be provided only in the lower half of a door. Where such an opening is in or under a door, the total net area of any such opening or openings shall not exceed 0.05 m^2. Alternatively, a non combustible air balance duct routed between the cabin and the corridor, and located below the sanitary unit, is permitted where the cross sectional area of the duct does not exceed 0.05 m^2. Ventilation openings, except those under the door, shall be fitted with a grill made of non combustible material.

Doors in the outer boundaries of superstructures and deckhouses are permitted to not have 'A' Class integrity may be of any material subject to compliance with load line requirements.

'A' Class door assemblies designed for interior use may not be suitable for use in positions exposed to the weather because of their light construction and susceptibility to corrosion.

For cargo ships and tankers the requirement for doors to be self-closing, only applies to the doors when the ship is in the upright position even though the Regulations do not specifically state this.

25. Fire Dampers

Fire dampers are provided in ventilation ducts and air intakes in order that in event of a fire sections may be sealed and isolated and so prohibit the passage of heat and smoke.

In its simplest form the damper will consist of a solid metal (steel) plate located inside an air duct. In its open position the damper allows the free flow of air through a duct and in its closed position it completely prevents the passage of air, smoke and heat through the duct.

All dampers are required to be manually operated.

Manual control of a fire damper is to be independent of and capable of overriding any automatic means of control.

Manual closing is normally by means of a handle linked directly to the damper blade spindle, but may be achieved by local operation of the fire damper by means of a fail-safe electrical switch or pneumatic release (spring loaded, etc.), on both sides of the division, with indication of fire damper status.

When a fire damper is required to be closed automatically, the means of operation shall be situated inside the coaming or spigot such that it can be activated by hot gases passing through the ventilation ducting. The MCA is prepared to accept any additional means of operating the damper automatically, subject to compliance with preceding paragraphs.

The means of operation shall be activated at temperatures within the range of 68°C to 79°C inclusive, except that in exhaust ducts serving spaces with high ambient temperatures such as galleys and drying rooms, the temperature at which the means of operation is activated may be increased to not more than 30°C above the maximum deck head temperature.

When the means of operating a fire damper automatically is a spring and fusible link, the link is required to be capable of being released manually from outside the duct by withdrawing the pin over which the link is hooked except that any other effective means of release would be considered.

A pneumatic or electrical system must be such that the fire damper closes on release of the air or failure of any one of the components or power supply.

In order to satisfy the requirements to operate a fire damper from both sides of a bulkhead or deck as indicated in the Regulations, a damper may be fitted on each side of the division within the coaming or spigot, the dampers being operated independently of each other. Only one of the two dampers need be capable of being closed automatically when automatic operation is required by the Regulations.

Alternatively a single manual or automatic damper as appropriate may be fitted on one side of the bulkhead or deck, arranged for local manual operation, and in addition for manual operation from the blind side of such a division using a suitable linkage. The instructions of this section should be complied with at both operating positions.

Each damper is required by the Regulations to be fitted with a visible indicator to show whether the damper is in the open or closed position. The method of indication should be visible from the operating position.
The manual and automatic controls, indicator, access panels and any other component should be sufficiently clear of the coaming to enable the coaming to be properly insulated.

Manual and automatic controls of a damper are to be clear of the division, the insulation on the division or any other obstruction when the damper is in the open and closed positions.
If any damper is located behind a deck head panel or other lining the access through the deck head or lining must be marked 'FIRE DAMPER'. There should also be a notation by which the particular damper may be identified.

26. Means of escape

The design of a vessel should allow for all crew to quickly and safely evacuate any compartment and access the survival craft embarkation deck in the event of a fire or other emergency.

Escape routes are both routes for escape and access. Escape routes shall be maintained in a safe condition, clear of obstacles and additional aids for escape shall be provided as necessary to ensure accessibility, clear marking, and adequate design for emergency situations.

At least two widely separated and ready means of escape shall be provided from all spaces or groups of spaces.

Lifts shall not be considered as forming one of the means of escape.

Escape panels should only be capable of being operated from that side of the door from which a person needs to escape and should be of such a design as to preserve the integrity and insulation standard of the door and prevent any unlawful entry into a space.

Escape panels should be marked with the words 'ESCAPE PANEL - KICK OUT' in white letters on a green background.

Every 'B' Class door fitted in a cabin bulkhead should be capable, when locked, of being opened manually from the cabin side other than by means of the key.

Any 'B' Class door, other than a cabin door, which is fitted to an opening forming part of an escape route should not be capable of being locked shut, except that when such a door is required to be locked shut by the owner for security reasons keys should be provided on each side of the door in glass fronted boxes fitted close to the door.

Stairways and ladder ways

The width is to be measured on the tread within the sides or between the handrails, whichever is the least.
Stairways should not extend in a single flight more than one deck or a vertical distance of 3.5m whichever is the least.

In either case, the stairways should be separated by a landing having its shorter dimension not less than the width of the wider stairway. However when it is only possible to arrange such stairways to slope in the same direction without being offset, they should be separated by a landing having a length not less than 2m.
Stairways and ladder ways should, as far as possible, be pitched fore and aft, not athwart ships, and should normally be inclined at not less than 45º to the vertical.
In general, the rise of each step should be kept constant to facilitate easy movement up (or down) the stairway, especially in an emergency situation.

Corridors and doorways

Corridors and doorways providing access to and from stairways or open decks should be of sufficient width to prevent congestion and, in the case of those serving stairways, should not be less than the width of the stairways.

Handrails should be fitted in corridors at an approximate height of 1000mm above the deck

Hatches

Where hatches are provided as the second means of escape for crew from accommodation spaces, the hatches should be of such dimensions as will allow a person to escape wearing a lifejacket.

Any hatch provided for escape from crew accommodation or working spaces should not be capable of being locked and should be operable from below and above. It is preferable for such a hatch to be provided with a counter-balance weight for ease of opening. Access to the hatch should be by means of a fixed steel ladder.

The escape hatches are so sited that they cannot be over-stowed with deck cargo or stores.

When the hatches are fitted in 'A' Class or 'B' Class decks, their construction should be such that the integrity and insulation standards of the decks are not impaired.

Crew mess rooms, recreation rooms etc.

When mess rooms, recreation rooms, television rooms and similar communal spaces are provided to accommodate more than 15 crew members at any one time, such spaces in general should have two doors to the adjacent corridor. In cases where this is not possible, in addition to the provision of a door to the corridor, a door to the open deck should be provided, or if this is also not possible, an escape window or side scuttle may be accepted.

Doors in crew accommodation

Doors in an escape route should not normally be locked closed. However, doors which give access to 'sensitive areas' may be locked for security purposes, provided the surveyor is satisfied that the escape routes will remain viable.

Unless expressly provided otherwise a corridor, lobby, or part of a corridor from which there is only one route of escape shall be prohibited. Dead-end corridors used in service areas which are necessary for the practical utility of the ship, such as fuel oil stations and athwart ship supply corridors, shall be permitted, provided such dead-end corridors are separated from crew accommodation areas Also, a part of a corridor that has a depth not exceeding its width is considered a recess or local extension and is permitted.

All stairways in accommodation and service spaces and control stations shall be of steel frame construction except where the Administration sanctions the use of other equivalent material.

If a radiotelegraph station has no direct access to the open deck, two means of escape from, or access to, the station shall be provided, one of which may be a porthole or window of

sufficient size or other means to the satisfaction of the Administration.

Doors in escape routes shall, in general, open in way of the direction of escape, except that: individual cabin doors may open into the cabins in order to avoid injury to persons in the corridor when the door is opened; and doors in vertical emergency escape trunks may open out of the

General

- At all levels of accommodation there shall be provided at least two widely separated means of escape from each restricted space or group of spaces.
- Below the lowest open deck the main means of escape shall be a stairway and the second escape may be a trunk or a stairway.
- Above the lowest open deck the means of escape shall be stairways or doors to an open deck or a combination thereof.
- No dead-end corridors having a length of more than 7 m shall be accepted.
- All ships shall carry at least two emergency escape breathing devices within accommodation spaces.
- Means of escape from control stations, accommodation spaces and service spaces

General requirements

Stairways and ladders shall be so arranged as to provide ready means of escape to the lifeboat and life raft embarkation deck from passenger and crew accommodation spaces and from spaces in which the crew is normally employed, other than machinery spaces.

Accommodation below the weather deck

The two means of escape from each group of accommodation spaces situated between main bulkheads below the weather deck should be stairways as widely separated as possible. One stairway should provide direct access to the embarkation deck or higher deck and the other stairway should lead to the deck over or a higher deck which provides access to the embarkation deck by means of internal stairways and/or doors in the boundaries of the deckhouses and external ladders. However, if this is not practicable, the stairway which leads to the deck over or higher deck may be replaced by a vertical ladder inside a trunk which provides the same degree of access
In certain circumstances, depending on the layout of the spaces under consideration and the position of the stairway, it may be necessary to provide two vertical ladders within trunks, one port and one starboard, in order to provide adequate means of escape from the group of spaces.

Accommodation above the weather deck

The two means of escape from each group of accommodation spaces situated above the weather deck should be stairways as widely separated as possible. One stairway should provide direct access to the embarkation deck or higher deck and the other stairway should lead to the deck over or higher deck which provides access to the embarkation deck except that this stairway need not be fitted if there is at least one door from the corridor serving the group of spaces in each side of the deckhouse which provides access to the embarkation deck. The two doors and the stairway providing direct access to the embarkation deck should be as widely separated as possible.
The escape routes are routes for escape and also for access. Accordingly, the locking arrangements should be such that it does not obstruct these two objectives (escape and access) and that the doors in way of the escape routes can be opened from both sides. The embarkation deck should be accessible from the open decks to which the escape routes lead.

trunk in order to permit the trunk to be used both for escape and for access.

Means of escape from machinery spaces

Means of escape from each machinery space shall comply with the following provisions.

Two means of escape shall be provided from each machinery space of category A. In particular, one of the following provisions shall be complied with:

Two sets of steel ladders, as widely separated as possible, leading to doors in the upper part of the space, similarly separated and from which access is provided to the open deck. One of these ladders shall be located within a protected enclosure, from the lower part of the space it serves to a safe position outside the space. Self-closing fire doors of the same fire integrity standards shall be fitted in the enclosure. The ladder shall be fixed in such a way that heat is not transferred into the enclosure through non-insulated fixing points. The enclosure shall have minimum internal dimensions of at least 800 mm x 800 mm, and shall have emergency lighting provisions; or one steel ladder leading to a door in the upper part of the space from which access is provided to the open deck and, additionally, in the lower part of the space and in a position well separated from the ladder referred to, a steel door capable of being operated from each side and which provides access to a safe escape route from the lower part of the space to the open deck.

From machinery spaces other than those of category A, two escape routes shall be provided except that a single escape route may be accepted for spaces that are entered only occasionally, and for spaces where the maximum travel distance to the door is 5 m or less.

Flexible ladders, i.e. ladders having strings of flexible steel wire rope (or chains) are not acceptable as forming part of any escape route.

Section E

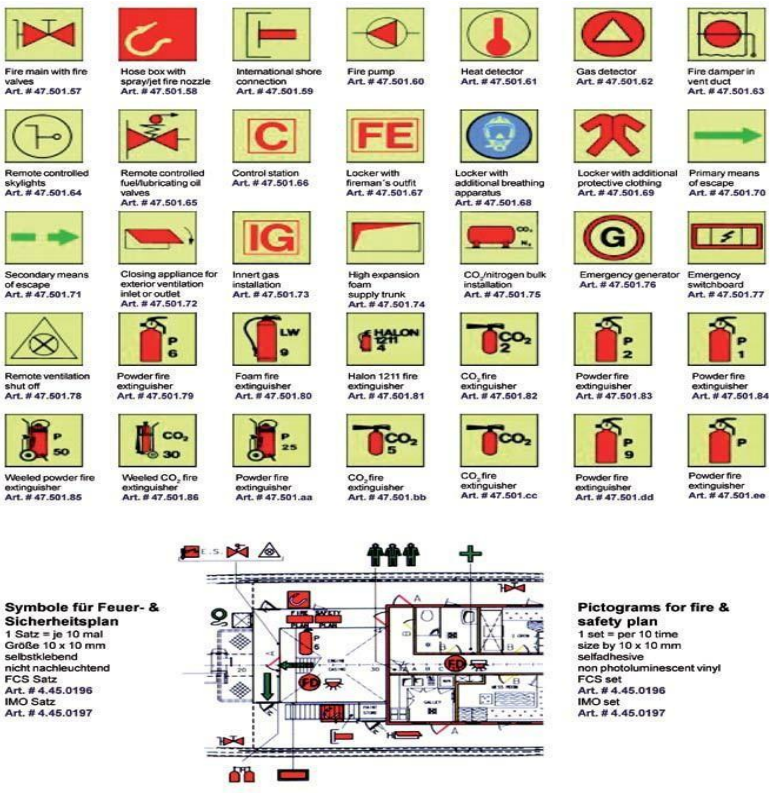
27. Fire control plans

All cargo ships of over 500 tonnes are required to permanently display a fire control plan. This is often a general arrangement type drawing on which is clearly shown:

- Fire control stations
- Fire sections enclosed by 'A' class divisions
- Fire sections enclosed by 'B' class divisions
- Location of the fire detectors and alarms
- Location of fire detector control panels
- Location of fire extinguishing equipment
- Means of access to different compartments and decks
- Ventilating systems
- Position of dampers and identification numbers of the ventilating fans serving each section

Below is an example of a fire plan and symbols which may be used

As an alternative to the displayed drawing the administration may allow the required information to be set out in a booklet. In this case a copy of the booklet is to be supplied to each officer, and one copy is to be readily available onboard.



A copy of the plan or booklet must be permanently kept in a watertight enclosure outside of the superstructure. The enclosure is to be coloured red, clearly marked, easily opened and located where it will not be easily cut off in the event of a fire. This copy of the fire control plan is for the use of shore side fire fighting personnel, should they ever be required onboard. Often it will be positioned close to the gangway, but if not, there must be signs directing the shore side fire fighting crew to its location.

Any changes or additions to the fire fighting equipment onboard must be approved by Flag, and the fire plans amended as appropriate, duly endorsed by the Flag Administration, or by Class

28. Heli - Deck Equipment

Vessels are required to provide fire fighting and rescue equipment where helicopters land or conduct winching operations on an occasional or emergency basis.

In close proximity to the heli-deck, the following fire-fighting appliances shall be provided and stored near the means of access to that heli-deck.

1. at least two dry powder extinguishers having a total capacity of not less than 45 kg
2. carbon dioxide extinguishers of a total capacity of not less than 18 kg or equivalent
3. a suitable foam application system consisting of monitors or foam- making branch pipes capable of delivering foam to all parts of the heli-deck in all weather conditions in which helicopters can operate.
4. at least two nozzles of an approved dual-purpose type (jet/spray) and hoses sufficient to reach any part of the heli-deck;
5. two sets of fire-fighter's outfits

At least the following equipment shall be stored in a manner that provides for immediate use and protection from the elements:

- adjustable wrench
- blanket, fire-resistant;
- cutters, bolt, 60 cm;
- hook, grab or salving;
- hacksaw, heavy duty complete with 6 spare blades;
- ladder;
- lift line 5 mm diameter and 15 m in length;
- pliers, side-cutting;
- set of assorted screwdrivers;
- Harness knife complete with sheath.
- A wrecking bar
- 2 aircraft axes of the non wedging type

Fire-fighting personnel consisting of at least two persons trained for rescue and fire-fighting duties, and fire-fighting equipment shall be immediately available at all times when helicopter operations are expected.

Fire-fighting personnel shall be present during any re-fuelling operations. However, the fire-fighting personnel shall not be involved with refueling activities.

29. **Fire fighting organization**

Details of the actions to take in the event of fire, the composition of fire parties and the methods of attack may vary from ship to ship.

Fire Drills

Each crew member must participate in at least one abandon ship drill and one fire drill every month. These drills must be held within 24 hours of leaving port if more than 25% of the crew have not taken part in drills on board the ship in the previous month. If circumstances are such that it is not practical to hold full drills within the 24 hours then musters should be held within this period. A fire drill must be held weekly and as many of the crew as practicable should take part in these drills which should be so arranged that each crew member participates in at least one fire drill every month.

A fire or other emergency drill shall as far as practicable be conducted as if it were an actual emergency.
A fire or other emergency drill should be held simultaneously with the first stage of the abandon ship drill.

For the purpose of a fire drill an outbreak of fire should be assumed to have occurred in some part of the ship and fire control measures simulated as appropriate. The complete cooperation of the personnel of all departments is essential in fire fighting. The type and position of the supposed fire should be varied from time to time and can include:

1. Cargo fires in holds or other spaces;
2. Fires involving oil, gas or chemical cargoes as appropriate;
3. Fires in engine, pump or boiler rooms;
4. Fires in crew accommodation; and
5. Fires in galleys due to burning oil or cooking fats.

The engine room staff should ensure that the fire pumps in the machinery spaces are prepared for operation, started, and that full water pressure is on the fire mains. Where there is an emergency fire pump situated outside the machinery space, this pump should be started up as indicated below. The fire party or parties at the scene of the assumed fire should lay out hoses and where practicable water should be played through them, the water being supplied first from the machinery space pump and then from the emergency pump only, with the machinery space isolating valve closed. A number of portable fire extinguishers should be available and members of the fire party should be instructed in the use of the type of fire extinguisher for a particular type of fire.

The crew should be exercised as appropriate in the closing of openings for example side scuttles, deadlights, doors, ventilating shafts, fire doors, the annular space around the funnel, etc both to reduce the supply of air to a fire and isolate it from other parts of the ship, especially stairways and lift shafts. As many of the crew as possible and particularly the officers should be made familiar with the position of remote controls for ventilation fans, oil fuel pumps and oil tank valves and be instructed in the method of operation thereof.
Fixed installations for extinguishing fire, such as CO2, foam, or water spray in the machinery spaces, CO2, inert gas, steam or drencher systems in the cargo spaces together with fire alarm and detection systems should be tested with as much realism as practicable. The fire party should also be exercised in the use of the breathing apparatus and protective clothing and such emergency appliances as axes and safety lamps, which should be brought out, checked and deployed by appointed members of the party at all fire drills. Where

the number of sets of breathing apparatus permits, it is recommended that persons using them should practice in pairs.

It is important that members of the crew who are not allocated to fire parties are familiar with the use of and can identify the types of fire extinguisher they will encounter in the accommodation and in their work areas. Such crew members should be instructed in the
use of the type of extinguisher appropriate to the kind of fire, for example those discharging foam, dry powder, CO2, etc.

At each fire drill at least one extinguisher should be discharged by a different crew member in order that both crew members in fire parties and other crew members gain experience in using fire extinguishers. Crew members should also be familiar with the location and means of activating the fire alarms in the accommodation and in their working areas. It is also important that all crew members and particularly those whose place of work is in a machinery space are familiar with the escape routes from any part of the ship they are likely to be in when on or off duty. Such familiarity should enable escape to be made in darkness or through smoke and should include familiarity with the location and the means of opening any emergency escape windows or hatches.

All fire protection systems and appliances should at all times be in good order and available for immediate use during the voyage and in port.

Compressed air bottles of breathing apparatus and fire extinguishers should be refilled after any drill. Where refilling facilities are not available on board additional equipment may be carried to facilitate training. Discharged equipment should be clearly marked and stored for refilling when in port. Equipment dedicated for training purposes should be marked ‘for training purposes only’.

Participation in fire drills may not necessarily imply direct involvement with fighting a fire and may include back-up to fire parties, being a member of the first aid party. Due to the small crew onboard it will be necessary for every member of the crew to be familiar with all aspects of fire-fighting and the use of all the fire-fighting equipment provided on board the ship.

A fire drill should build the confidence of the crew in the following

- In the equipment and in the system
- Learn leadership skills
- Develop an understanding of problems that might be encountered
- In managing a fire situation

Testing and Inspection

To ensure the ready availability of fire protection systems and appliances periodic checks should be performed. The following checklist may be used as guidance for this purpose.

Monthly testing and inspection should be carried out to ensure that:

- All fire outfits, fire extinguishers, fire hydrants, hose and nozzles are in place and in serviceable condition;
- all escape routes including stairways and corridors are free of obstructions and properly maintained;
- public address system and ship's alarms are serviceable;
- all fixed fire fighting installation valves are set in the correct operational position;
- all fire pumps are operational; and
- all fixed gas fire extinguishing installations are free from leakage.

Quarterly testing and inspection should be carried out to ensure that:

- all fire extinguishers are at correct pressure and are not due for service
- the international shore connection is serviceable;
- fire fighting equipment lockers contain their full inventory and the equipment they contain is in serviceable condition; and
- all fire doors, fire dampers and closing devices can be operated locally.

Annual testing and inspection should be carried out to ensure that:

- all fire doors, and ventilation dampers where appropriate, operate remotely;
- where practicable all aqueous foam and water spray fixed fire fighting installations operate correctly;
- all accessible components of fixed fire fighting systems, typically nozzles, are free from damage or obstruction on visual inspection;
- all fire pump systems develop correct pressures and flow rates;
- all hydrants operate;
- fixed fire detection systems operate correctly, according to manufacturers test instructions.

Contingency plans

Assessment of and reaction to a fire situation may be more effective if some preplanning has taken place.
Know where chemicals, paints and compressed gases are stowed
Pre-determine the preferred entry route for various compartments and various situations. In a given situation will you attack the fire, batten down and contain the fire, or use a fixed flooding system
Do not develop plans that rely on a single person completing a specific act.

Muster lists

The requirements relating to muster lists apply to ships engaged on international voyages and to passenger ships of Classes II(A) and III. The Master is responsible for compiling the muster list, keeping it up to date and ensuring that copies are exhibited in conspicuous places throughout the ship, including the navigating bridge, engine room and crew accommodation.

In ships with significant numbers of non - English speaking crew members, the muster list should include translations into the appropriate language or languages.

The muster list must contain details of the general emergency alarm and other emergency signals and the action to be taken by the crew. Where appropriate, communication equipment, channels and the reporting chain to be used during an emergency should be specified.

The muster list must show the duties to be carried out by each member of the ship's complement in a fire fighting situation.

As far as practicable each individual should only be allocated one duty,

When the muster list is compiled consideration should be given to the eventuality of key persons being unable to carry out their emergency duties through injury or for some other

reason, and provision made for substitutes. This provision must be shown on the muster list.

When allocating substitutes care should be exercised to ensure that emergency parties are not left without a leader or seriously undermanned.

At the muster stations all persons must be accounted for. Thereafter each group leader must, at all times, be aware of the safe situation of each member of this team.

Leadership

- Take charge of the situation
- Keep the whole picture in mind. Do not focus over-intently on one aspect or detail
- Give orders in a clear and concise manner, but without hysteria or panic
- Listen to advise, but do not allow argument
- Be flexible and continually reassess the situation, but do not allow this to be interpreted as indecisiveness
- Key person substitutes must be clearly identified beforehand and suitably trained
- Leadership of individual parties may vary with the circumstances. An engineer may lead a fire party in a machinery space, whilst a deck officer may lead the party in other situations.
- Delegate specific duties as may be required.
- The commander or team leader must not take on tasks which inhibit their ability to keep in view the whole picture, or which limit their ability to lead

The Command Team

Responsibilities of the command team include:

- Keeping overall control of the various parties.
- Monitoring the event and assessing the effectiveness of the fire attack.
- Accounting for the whereabouts of all persons on board
- Recording times, events and communications
- Manoeuvring the vessel as most appropriate for the situation
- Monitoring the vessel's stability and assessing the free surface effect of any water used
- Collating and disseminating information from and to all concerned parties
- Communicating with other vessels and rescue services

Contingency must be made for an alternative venue from which the command team may operate should the chosen position be inaccessible.

Fire Control

A fire is contained by

I. Boundary Cooling
II. Boundary Starvation
III. Ventilation Control

Boundary Cooling

Decks and bulkheads must be wetted – having first isolated any electrical circuits – in order to prevent the fire spreading by conducted heat. Only apply the minimum amount of cooling water and don't leave hoses unattended. Whilst boundary cooling care should be taken not to build up an area of free surface water, this may have an effect on stability.

Boundary Starvation

Boundary starvation involves the removal of any combustible material from any adjacent spaces. It may be necessary to remove bulkhead and deck head panelling and other fixtures.

Ventilation

The control of ventilation in a fire situation gives rise to two potential difficulties:

- To continue ventilation may allow air to perpetuate and even increase the fire.
- To close off the ventilation will trap heat and smoke, possibly in increasing amounts

To ventilate or not must be carefully considered. When a space has been completely closed down, it may be decided after boundary cooling that the fire fighters should enter or re-enter wearing breathing apparatus. A low entry point would be best to avoid the accumulated heat, smoke and gases, but fire fighting 'upwards' is difficult and consuming. In this situation it is necessary to carefully weigh the advantages and disadvantages of various re-entry points.

When determining the amount of ventilation and its nature the following considerations may apply.
What would be the natural flow of gases in the compartment on fire?

What effect would open apertures and forced ventilation have on the flow?

Can the hot gases be blown back at the fire fighters?

Will the venting of hot gases cause the fire to spread or obscure vision elsewhere?

30. Using a fire blanket

Fire blankets are often found in the galley and pantries and are suitable for contained fat fires, containing liquid fires, and other small fires.

Before you use a fire blanket you should ensure that you are between the fire and an exit so you are not trapped. Remove the blanket from its case by pulling the tapes. Hold the blanket so as to keep heat and flame off your face and body, but do not obscure you vision or path to the fire. Ensure you do not trip on the blanket. Shield your face, arms and hands with the blanket by wrapping the outside of the blanket around your arms; cover the fire completely with the blanket. Do not throw the blanket down, as this may drive air into the fire and cause it to be more intense or cause a plume of flame. Ensure that the source of ignition is turned off and leave for at least 30 minutes closing the door behind you.

You should not re-use fire blankets once they have been used on a fire. If you are smothering a clothing fire you should tightly wrap the blanket around the person whose clothes are burning and roll that person on the floor in the blanket for maximum effectiveness, but do not leave them within the blanket as this may trap heat and cause further injury. You should display the fire blanket ID sign above your wall mounted fire blanket to clarify how on to use the blanket safely. This sign should not be used as a training substitute but a back up to training.

The fire blanket should be mounted in a useful, prominent and accessible place, preferably on an escape route. Do not place over cookers or heaters or in the way of any fire risks.

31. Searches

Moving around

In smoke or other conditions of restricted visibility it is necessary to work by touch. Because of this there is a risk that the fire-fighters may become casualties themselves, so it is very important that during drills the crew practice some simple but effective search techniques

Shuffle the feet – The weight of the body should be placed on the rear foot until the front foot has tested it is safe to move forward. Feet should not be lifted from the deck, sliding the feet will help detect obstructions and dangers such as projecting nails, stairs, fallen items etc.

The fire fighter should hold a free hand in front of the face at 30 – 40 cm. The hand should be slightly cupped palm towards the face. As the fire fighter advances, the fire fighter slowly moves his hand up and down to ensure that neither head nor face strike an obstruction.

In smoke the air will be coolest near the floor and it will be advantageous to keep low and crawl to avoid excessive heat. From a low, relatively smoke free position it is sometimes possible to detect a fire glow which has been obscured when standing up.

When descending stairs, walk backwards. This will shield the face from heat and allow a more secure hand hold.

Smoke

Smoke may travel a considerable distance from the source and its presence may not indicate where the fire is seated. The volume of smoke is not always a true guide to the size of the fire. Smoke rises when heated and sinks as it cools. It will rise until it meets a deck head or other obstruction when it spreads sideways. Due to behaviour of smoke and the possibility of getting lost in smoke it would be beneficial if:
The fire fighter is familiar with the area being searched.
The fire fighter takes note of any features which will assist in retracing the route to safety.
Hose / guidelines may be used to retrace a route but great care must be taken.
If lost in a space make for a bulkhead and then follow it in a continuous direction until the exit is found, sound may be a good indication of an exit.

Patterns

The search used may be either a ‘right hand’ or ‘left hand’ pattern. The search investigates a compartment by moving continuously in and methodically in one direction, either right or left.
Circulate the area or compartment around the perimeter or bulkhead back to the commencement or entry point. Search in pairs, one man uses the back of his glove to maintain contact with the bulkhead or perimeter, the second person adds width to the search by walking abreast of the first and maintains contact with him by placing his hand on a shoulder. The free hand of each fire fighter is position as mentioned above to protect the face. The fire fighters proceed by shuffling their feet.
The search would commence at the point of greatest danger so that the searchers are nearest fresh air and safety at the end of the search. Pay attention to doors and openings so that they are not passed without completing the search of each compartment and alcove. Trapped people often take refuge in wardrobes, cupboards etc, make sure a full search of these areas is complete.

32. Fire fighting techniques

Attack options:

Direct Attack - Preferred method

Fog Attack - Used when:

- Overhead gases are burning (Rollover)
- Seat of fire is obstructed
- Multiple seats of fire present
- Indirect Attack
- Attacking from space above

Hose Handling

- Preliminary Actions to Ensure Readiness
- Proper stowage of hoses
- Hand tight couplings
- Hoses in good condition
- Hose reel brakes properly set
- Teamwork / Coordination is the key to Success!

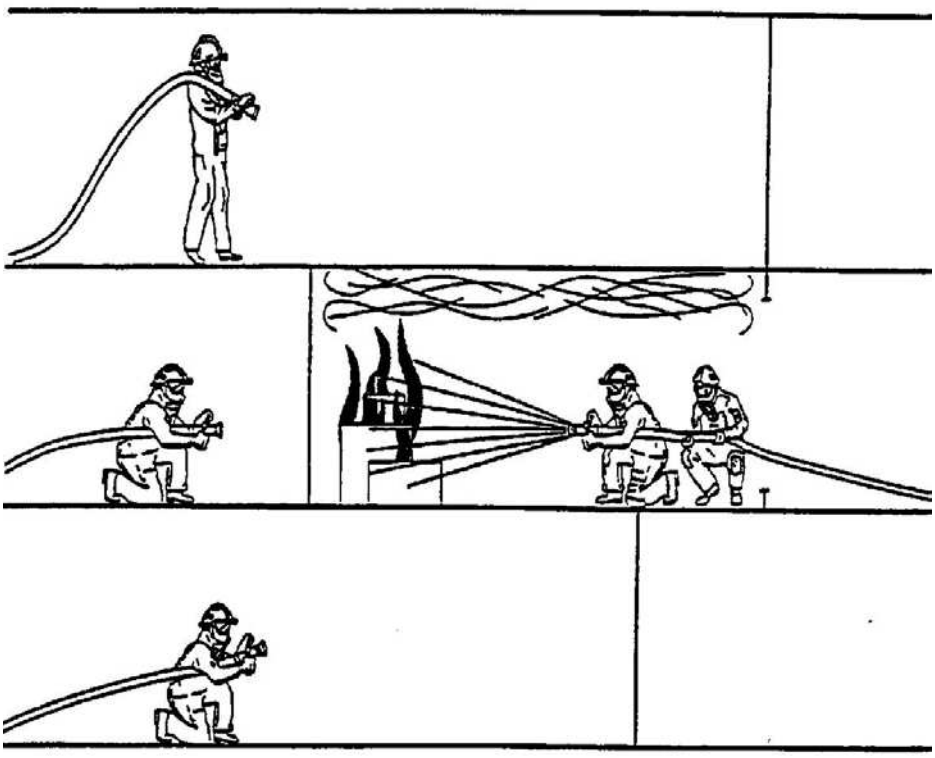
Advancing the Hose

1. Advance to nearest location possible to affected space prior to charging
2. With hose unreeled, charge hose (slowly), straighten kinks and check for leaks
3. Experience has shown that hoses expand when charged, causing difficulty removing from hose reel
4. When manoeuvring below decks place all hose handlers on the same side of the hose for ease of movement in narrow areas
5. When using 2 hoses alongside one another, place hose handlers on outside of hoses to minimize interference

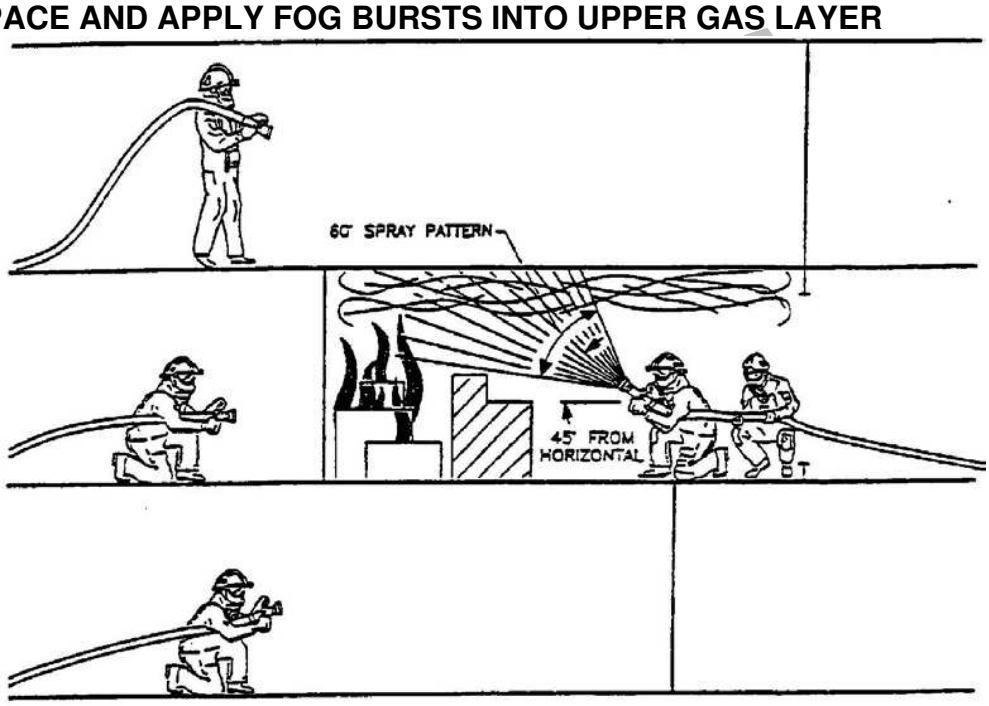
Space re-entry

1. Position fire-fighters on the non-hinged side of door, hose line ready. Stay low!
2. When door is opened, if fire shows or rolls out, direct water fog at the doorway overhead for cooling and control of escaping gases.
3. When conditions permit, Team Leader enters the space and assesses conditions. Remain low!
4. If mission requirements dictate rapid entry, crawling into the space may be required.
5. Sweep deck with hose stream to clear debris, cool hot surfaces and burning materials, prevent burns and damage to hose lines.

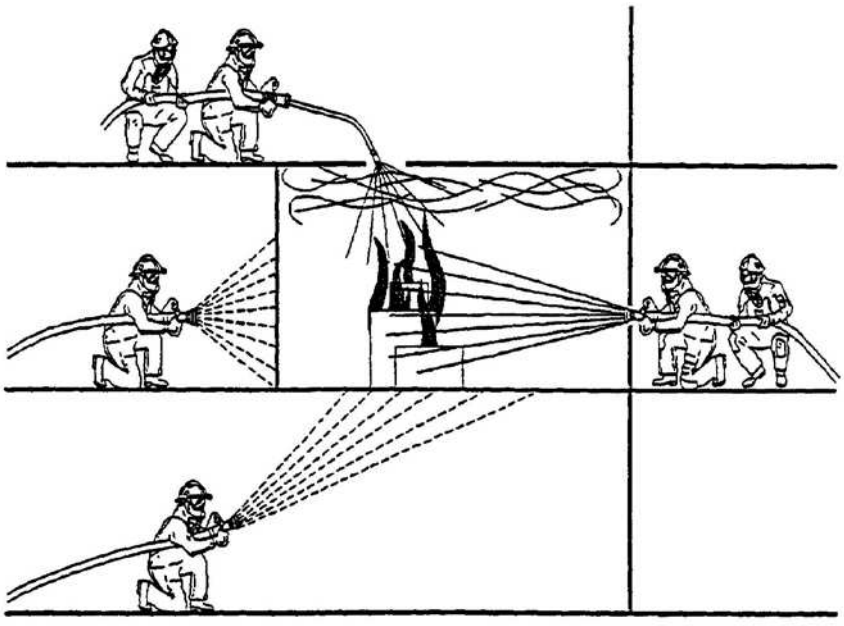
PREFERRED METHOD ENTER SPACE AND APPLY WATER TO THE SEAT OF THE FIRE



IF DIRECT APPLICATION OF WATER TO THE SEAT OF THE FIRE IS NOT POSSIBLE ENTER SPACE AND APPLY FOG BURSTS INTO UPPER GAS LAYER



IF HIGH TEMPERATURE DENIES ACCESS CONDUCT INDIRECT ATTACK



If the high temperature denies access you may vent the heat to weather and conduct indirect attack like the one shown above.

Attacking from above

When attacking from the space above the following should be considered when conducting either a direct or indirect attack from the hot deck over the fire space.

Rotate personnel frequently to avoid heat strain. Emphasis should be on each person or team accomplishing a minor task rather than staying until exhausted.

Keep team leader outside high heat area to prevent impaired judgment and increase endurance.

Avoid stationing personnel at local hot spots such as immediately above the fire. Utilize

support team personnel for indirect cooling and gaining access. These jobs are physically demanding and should not be performed by the primary attack team. Using

additional gloves for hot surfaces during access may prevent burned hands. **Backup**

hose considerations

Decision to layout, man, charge or bring the back-up hose to the scene of the fire made by the OSL based on following:

- Is a second hose required for fire attack?
- Are burning gases present in the overhead?
- Are combustible materials near the scene of fire that requires cooling?
- Is protection required for primary attack team due to high probability of explosion?

Attack team relief

- Relieve as a team.

- Manage relief's from a single control point
- Personnel standing by should minimize heat stress while waiting
- Personnel relieved should proceed to fresh air, cool off and replenish body fluids

33. Accommodation Fires

Accommodation fires may present some serious problems. In most vessels deck heads and bulkheads voids which carry electrical cables and plumbing services, provide a channel for an unrestricted air supply which may feed a fire. Additionally, each cabin and compartment may have a ventilation trunk linking it with other compartments and providing a means of air supply and smoke distribution. Alleyways, stairwells and lift shafts promote the spread of fire smoke, fumes and heat to areas remote from their source.

The use of plastics and other synthetic materials in furniture, curtains, bulkheads panels and other décor may, in a short space of time and even from a small fire, produce large volumes of toxic fumes and thick smoke. These are life threatening to anyone in the vicinity or connected via a ventilation route. Even large areas may quickly become smoke filled. Below is an example of a ships accommodation.

The fire may be contained by boundary cooling and boundary starvation. Give careful consideration to ventilation control and seek to remove heat, smoke and fumes without feeding air into the fire. Check remote areas for the spread of heat, smoke and fumes via ventilation ducts, voids and lift shafts etc.

Water spray is often effective in tacking accommodation fires, but care must be taken with respect to the isolation of electrical circuits and stability.

34. Machinery space fires

The main dangers in machinery spaces are those posed by oils, often under pressure, in close proximity to heat, machinery running at high temperatures and turning at high speeds, a multitude of electrically driven items, switchboards and generators.

The effect of an oil fire in a machinery space enclosed with metal bulkheads is that there is often a rapid rise in temperature which presents a situation where controlled venting may be required to remove heat and humidity
Situations that may give rise in the machinery space include fractured fuel lines, overheated bearings, boiler flash backs, crankcase explosions, electrical faults and overloads, negligence and human error.

Fixed extinguishing installations are usually available for fire fighting in machinery spaces. The decision as to use such a system will be taken by the master.

Considerations concerning its use include:

- Are there any persons in the compartment and will use of the system be harmful or fatal to them?
- Is it possible to use the system partially only?
- Does the system have one shot only?
- Having used the fixed system for how long will we be without engine power and maneuverability?
- A fixed gaseous system has no cooling effect. After use will we be able to reduce the temperature in the space so there is no danger of re-ignition when the space is opened up?

35. Fires in port

A fire on board whist the vessel is in port may pose some additional difficulties, but may also mean that the local fire brigade is readily available.

Some difficulties with fires in port

1. Not all of the members of the firefighting team may be onboard
2. Exact number of crew onboard may not be known.
3. Number of shore representative and visitors onboard may be difficult to determine. i.e. when the vessel is in dry dock.
4. Any non-ship personnel onboard may not be familiar when the vessel, alarm signals and procedures.

To Mitigate against these difficulties

1. All non-ship personnel should be given a full safety briefing on arriving to the vessel
2. A tally system should be used
3. The number of crew permitted ashore should be consistent with maintaining adequate emergency cover onboard, unless shore side have taken full responsible for the fire fighting on the vessel in writing.
4. Any fire onboard when in port should be immediately reported to the Fire Brigade.

When attending the fire the fire brigade will ask to see the vessels fire control plan and should be fully briefed by the officer in charge.

Information which may be passed over to the fire brigade includes: I.

Location of fire
II. What is burning
III. How long has it been burning
IV. How did it start V.
Access options VI.
Adjacent risks
VII. Other risks onboard (e.g. cargo)
VIII. Is there anyone missing
IX. Stability situation
X. What action has already taken place by vessel's staff
XI. Fixed fire fighting systems available.
XII. How the vessels fire zones are arranged

Although the local fire brigade may be present the ship's master is still responsible for the safety of the vessel and the crew. Co-operation is the key between ships crew and shore fire brigade.

Section F – Fire safety precautions of handling cargo

36. Responsibilities

Responsibility for the general fire safety on board the vessel, whether during loading or discharging operations and when at sea rests with everybody on board the vessel. Common sense, diligence, quick reporting and clear communications are paramount to successful monitoring of all situations. Operating the vessels equipment correctly and reporting any damages will reduce risks. A high standard of housekeeping and hygiene will also reduce risk. Specific responsibilities are outlined below but requirements/instructions are contained elsewhere as listed below and must always be followed and implemented by all officers and crew when carrying out their duties. These instructions and orders will vary from ship to ship and between vessel types:

- Company Standing orders
- Master Standing Orders
- Night Orders issued by the Master or Ch. Engineer
- Cargo plans and orders issued by the Ch. Officer
- Standing Orders – Cargo transfer procedures
- Guidelines stated on MSDS sheets
- Vessel specific Operational Procedures and Contingency Plans
- SOPEP/SMPEP

The Master.

- The Master has the ultimate responsibility for all safety matters. In any Emergency Situation, the Master is, whenever possible, to take station on the Bridge - if conditions preclude this, he is to make everyone aware of where he is stationed so as to enable proper reporting procedures.
- If an Emergency Situation is so extreme as to warrant his personal presence, the Master is to delegate a responsible Officer to stand in his place on the Bridge.
- For Command purposes at the actual site of the Emergency the following applies

Safety of Cargo.

Whilst in times of emergency the priority must be for the safety of personnel and the ship, the safe stowage and carriage of cargoes will contribute towards ensuring the overall safety and in reducing the likelihood of an emergency situation arising.

The safety and security measure necessary varies depending upon the nature of the cargo and the type of vessel.

The requirements for Cargo Handling and Care in the documented procedures, if met ensure the safety and security of cargo.

On vessels fitted with the monitoring devices to safeguard the condition of cargoes, it is the responsibility of the Master to ensure that such devices are maintained in working order and are tested and calibrated as necessary in accordance with manufacturer's instructions.

The vessels cargo plan is to indicate all the measures that are necessary to safeguard the condition and security of the cargo.

The Chief Engineer

- Is responsible to the Master for:
- Fire Fighting Within the Machinery Spaces
- Coordination for Oil Spill Containment
- Coordination for Damage Control Assessment
- Dealing with an Engine Room Catastrophe

The Chief Officer

Is responsible to the Master for:

- Emergency and Safety Training of on board Personnel
- Responsible for Safety of Personnel Whenever An Incident Occurs
- Organising Search and Rescue Parties
- Organising Isolation of Ventilation If Necessary
- Local Command of Fire Fighting and Emergency Activities Everywhere Except for Machinery Spaces
- Stability and Stress Calculations Where Necessary

37. Flammability, Flashpoint and Ignition Temperatures

Flammability

The main factors, which determine flammability, are:
Flammable Range - is the range between the Upper and Lower Flammable (or Explosive) Limits usually expressed as UFL (or UEL) and LFL (or LEL).Petroleum gases can be ignited and will burn only when mixed with air in certain proportions. Below the LFL, the mixture of hydrocarbon gas and air is too weak to burn, and above the UFL there is insufficient air present to support combustion. The Flammable Range of most petroleum lies between 1% and 10% by volume in air.

When petroleum is ignited, it is the gas progressively given off by the liquid, which burns as a visible flame. The quantity of gas available to be given off by petroleum liquid depends on its volatility.
Volatility or Vapour Pressure - is the tendency of a liquid to vaporise or give off gas. It is usually expressed in terms of Reid Vapour Pressure (RVP).Most crude oils have RVP's of between 1 and 12 psia. A substance with a RVP of 14.7 psia would be a gas at normal temperature and pressure.
As petroleum liquid is heated the concentration of gas in air above it increases. The temperature of the liquid at which this concentration reaches the lower flammable limit is known as the flashpoint of the liquid.

Flash point and Ignition Temperatures

Flash Point is the lowest temperature at which sufficient vapour is being given off for there to be a flash if an ignition source is introduced.
Ignition Temperature, sometimes known as Fire Point, is the lowest temperature at which the introduction of an ignition source would result in a flash followed by a fire.
Self-Ignition Temperature, sometimes referred to as Spontaneous Ignition Temperature, is the temperature at which a substance will ignite without the introduction of an external ignition source.

The following are some examples of Flash Points and Self-Ignition Temperatures:

Fuel	Flash Point	Self Ignition Temp
Methane -	175 C	595 C
Butane -	60 C	365 C
Butane -	76 C	500 C
Propane -	105 C	468 C
Gasoline -	40 C	468 C
Diesel Oil	71 C	338 C
Fuel Oil	82 C	255 - 410 C
Lubricating Oil	148 C	260 C
Cooking Oil	250 C	370 C
Wood	232 C	

The following temperatures have been included for purposes of comparison.

Match Flame	900 C
Cigarette	300 C
Open Light Bulb	120 C

38. Safety precautions and emergency procedures

Terminals

Terminals have safety regulations which must be complied with by both tanker and terminal personnel. All tankers at the terminal should be aware of such regulations, together with any other regulations relating to the safety of shipping which may be issued by the appropriate port authority. A sufficient number of personnel to deal with an emergency should be present both on board the ship and at the shore installation at all times during the ship‘s stay at the terminal. Those personnel involved with the operations should be familiar with the risks associated with handling dangerous cargo.

After the tanker has berthed the terminal representative should contact the responsible officer to:

- Agree designated smoking places.
- Agree galley equipment and cooking appliance limitations.
- Advise on “work permit” and “hot work permit” procedures.
- Advise on other relevant activities in the vicinity.
- Provide information about other terminal or local safety and firefighting regulations.
- Exchange information on the availability and use of fire fighting and emergency equipment on the terminal and the tanker.
- Discuss the action to be taken in case of fire or other emergency.

Readiness of Fire Fighting Equipment

Firefighting equipment should be ready for immediate use on board of the vessel and at a terminal. Fire hoses are sometimes connected to the ship’s fire main, one forward and one aft of the ship’s manifold. When monitors are provided, they should be pointed towards the manifold and be ready for immediate use. Portable fire extinguishers, preferably of the dry chemical type should be conveniently placed near the ship’s manifold. If a stern loading/discharging manifold is used, sufficient firefighting equipment must be available in the vicinity to provide an adequate level of protection at that location. If practicable, a pump should maintain pressure on the ship’s fire main while cargo or ballast is being handled. If it is not possible the fire pump should be in standby condition and ready for immediate operation. While a tanker is berthed at the terminal its boilers, main engines, steering machinery and other equipment essential for maneuvering should normally be maintained in condition that will permit the ship to move away from the berth at short notice.

Repairs and other work, which may immobilize the tanker, should not be undertaken at the berth without prior, written agreement with the terminal.

Communications

Telephone, portable VHF/UHF and radiotelephone systems should comply with the appropriate safety requirements. The provision of adequate means of communication, including a back-up system between ship and shore, is the responsibility of the terminal. Communication between the responsible officer on duty and the responsible person ashore should be maintained in the most efficient way. Where there are difficulties in verbal communications, these can be overcome by appointing a person with adequate technical and operational knowledge and sufficient command of a language understood by both ship and shore personnel.

Communication Equipment

Transmissions from a ship's main radio station can cause electrical resonance in insulated parts of some ship fittings such as mast stays and this can cause arcing across deck fittings. Similar arcing can occur on ship's wireless aerials especially over the surface of insulators when they have a coating of salt, dirt or water. Radio transmission should not be permitted during periods when there is possibility of flammable gas in the region of the

antennae or where there is doubt about the effective earthling of stays, derrick equipment and other such fittings. When the tanker is at berth the main transmitting antenna should be grounded. If it is necessary to operate the ship's radio in port for servicing purposes, there should be agreement between tanker and terminal on the procedures necessary to ensure safety.
Items such as mobile telephones and radio pagers should only be re-commissioned once they are in a safe area, such as within the ship's accommodation.

Notices
Regulations regarding smoking and the use of naked lights should be strictly enforced. On arrival at the terminal, a tanker should display notices at the gangway inappropriate language stating:
NO NAKED LIGHTS
NO SMOKING
NO UNAUTHORISED PERSONS

Radar Usage
The radiation of radar waves from a properly sited radar scanner presents no ignition hazard on board a vessel, but the operation of high powered 10 cm radar may induce an electrical potential into nearby conductors at the berth. Consultation between the tanker and the terminal is therefore essential before using or repairing this equipment if the area near the scanner mechanism falls within ashore hazardous zone.

Satellite Communications Equipment
Satellite Communications Equipment normally operates at 1.6 GHz and the power levels generated are not considered to present an ignition hazard. As the positioning of the antennae may, however, involve the running of non-approved electrical equipment, consultation between the tanker and the terminal is advisable before the satellite terminal is operated.

Electrical Storms (Lightening)
A number of serious fires and explosions have occurred as a result of lightning striking ships and igniting cargo vapours. All oil tankers, that are required inert gas generators to be fitted, will operate in a fully inerted conditions and cargo operations must be conducted in close cycle. During gas freeing operations, particular attention must be given to tank atmosphere control in order to prevent flammable mixtures developing. Cargo, tank cleaning and gas freeing operations are to be suspended when electrical storms are in the vicinity. All openings to cargo tanks must be securely closed and cargo tank vent by-pass valves closed. Should a mast riser fire occur during loading, ballasting, or gas freeing, where safe to do so, the vapour/gas source should be isolated as soon as possible while the surrounding areas are kept cool with a protective water spray. If possible, the fire should be extinguished by inert gas or steam (if a suitable connection is fitted) while the riser and surrounding areas are kept cool with water spray.

Impact Sparks
The risk of ignition of petroleum vapours from impact sparks created by hand tools is only slight but is considered as a risk; however an incentive spark can be produced by impurities, such as sand or grit, being present between the impacting surfaces. Power tools such as pneumatic scaling hammers, wire brushes and angle/disc grinders can create sparks of sufficient intensity to ignite flammable vapours and must not be used where such risk exists.
Aluminium, magnesium and their alloys will readily produce sparks of high intensity if struck against steel. These sparks are known as "thermite" sparks and will readily ignite flammable vapours. Thermite sparks can also be produced if rust smeared with aluminium, or even aluminium based paint, is struck. For this reason, care must be taken to

avoid dragging aluminium fittings, such as gangways, across steel decks. Similarly, the use of aluminium based paints is prohibited anywhere outside of the engine room in tankers. To prevent ignition from the above sources, all cargo tanks must be leak free and be kept pressurized with Inert Gas. Venting systems must be correctly set and fully operable.

Pyrographic Ignition
Rust in the ullage spaces of cargo tanks and holds can react with the hydrogen sulphide contained in "sour" crudes to form a material that, on exposure to air, undergoes pyrophoric oxidation. The material becomes incandescent during this process and if the atmosphere in the ullage space lies within the flammable range, fire or explosion will result. Instances of pyrophoric reaction in cargo tanks are not common and the process can be controlled by ensuring that the atmosphere in the ullage space is maintained inerted to below 8% oxygen at all times until tanks have been washed ready for gas-freeing.

Galley Stoves
Before permitting the use of galley stoves and other cooking appliances while tanker is at a petroleum berth, the ship's master and the terminal representative must, after taking into consideration the location, construction and ventilation of the galley, jointly agree that no danger exists. Particular care must be taken when making this judgment if the stern loading/discharging manifold is to be used to transfer cargo.

Accommodation Openings
All access doors to the accommodation should be kept closed during cargo transfer operations. The Master should designate those access doors that are to be used for personnel transit. All doors opened for personnel transit should be closed immediately after use.

Liaison between Tanker and Terminal before Cargo Handling
The completion of a safe and successful cargo handling operation is dependent upon effective co-operation and co-ordination between all the parties involved. Exchange of information between the tanker and the terminal relating to cargo, ballast, bunker handling and emergency procedures should be exchanged before these operations begin. On the basis of the information exchanged, an operation agreement (loading/discharging plan) should be made in writing between responsible officer and terminal representative. The Ship/Shore Safety Check List should be completed to ensure the safety and fire prevention of both ship and terminal.

Hydrocarbon gas evaluation.
During many cargo handling operations, petroleum gas is expelled from cargo tanks vents in sufficient quantity to give rise to flammable gas mixture in the atmosphere outside the tanks. A major objective is to avoid such a flammable gas mixture being exposed to a source of ignition. In many cases this is achieved either by eliminating the source of ignition or by ensuring that there are barriers, such as closed doors and ports, between the gas and unavoidable potential sources of ignition.

Cargo Tank Inerting/Purging.
Hydrocarbon gas normally encountered in the petroleum tankers cannot burn in an atmosphere containing less than approximately 11% oxygen by volume. Accordingly, one way to provide protection against fire or explosion in the vapor space of cargo tanks is to keep the oxygen level below that figure. This is usually achieved by using a fixed piping arrangement to blow inert gas into each cargo tank in order to reduce the air content, and hence the oxygen content, and render the tank atmosphere non-flammable. For practical purposes and to allow a safe margin, 8% is taken as the level of oxygen which no hydrocarbon gas/air mixture can burn under any circumstances. To prevent fire or explosion in a tank coating a hydrocarbon gas/air mixture it is therefore necessary to produce and

supply inert gas having oxygen content not normally exceeding 5% and to displace existing air in the tank until the resultant oxygen level throughout the tank does not exceed 8% by volume. Ideally the inert gas should not contain oxygen but this is not possible in practice. The replacement of a tank atmosphere by inert gas can be achieved by either inerting or purging. In each of these methods one of two distinct processes: dilution or displacement will predominate.

- Dilution takes places when the incoming inert gas mixes with the original tank atmosphere to form a homogeneous mixture through the tank so that, as the process continues, the concentration of the original gas decreases progressively. It is important that the incoming inert gas has sufficient entry velocity to penetrate to the bottom of the tank. To ensure this a limit must be placed on the number of the tanks, which can be inerted simultaneously.
- Displacement depends on the fact that inert gas is slightly lighter than hydrocarbon gas so that, while the inert gas enters at the top of the tank, the heavier hydrocarbon gas escapes from the bottom through suitable piping. When using this method it is important that the inert gas has a very low velocity to enable a stable horizontal interface to be developed between the incoming and escaping gas although, in practice, some dilution inevitably takes place owing to the turbulence caused in the inert gas flow. This system generally allows several tanks to be inerted or purged simultaneously.

A mixture of inert gas and petroleum gas when vented and mixed with air can become flammable. The normal safety precautions taken when petroleum gas is vented from a tank should therefore not be relaxed.
When the tank is purged with inert gas and the hydrocarbon content is reduced to 2%or less by volume so that during the subsequent gas freeing no portion of the tank atmosphere is brought within the flammable range. The tank may then be gas freed. The hydrocarbon content must be measured with an appropriate meter designed to measure the percentage of hydrocarbon gas in an oxygen deficient atmosphere. The usual flammable gas indicator
is not suitable for this purpose.

Gas Freeing
Gas freeing and tank-cleaning operations are the most hazardous period of tanker operations. The additional risk from the toxic effect of petroleum gas during this period cannot be over-emphasised and must be impressed on all concerned. It is therefore essential that the greatest possible care is exercised in all operations connected with tank cleaning and gas freeing. The following procedures apply to the cargo tank gas freeing generally:

- Covers of all tank openings should be kept closed until actual ventilation of the individual tank is about to commence.
- Portable fans and blowers should only be used if they are hydraulically, pneumatically or steam driven. Their construction materials should be such that no hazard of incendiary sparking arises if the impeller touches the inside of the casing.
- The venting of flammable gas during gas freeing should be by the vessel's approved method, and where gas freeing involves the escape of gas at deck level or through tank hatch openings the degree of ventilation and number of openings should be controlled to produce an exit velocity sufficient to carry the gas clear of the deck.
- Intakes of central air conditioning or mechanical ventilating system should be adjusted to prevent the entry of petroleum gas, by re-circulation of air within the spaces.
- At any time it is suspected that gas is being drawn into the accommodation, central air conditioning and mechanical ventilating system should be changed for re-cycling.

- Window type air conditioning units which are not certified as safe for use in the presence of flammable gas or which draw in air from outside the superstructure must be electrically disconnected and any external vents or intakes closed.
- Where cargo tanks are gas freed by means of one or more permanently installed blowers, all connections between the cargo tank system and blowers should be blanked except when the blowers are in use.
- Tank openings within enclosed or partially enclosed spaces should not be opened until the tank has been sufficiently ventilated by means of openings in the tank that are outside these spaces. When the gas level within the tank has fallen to 25% of the LFL or less, openings in enclosed or partially enclosed spaces maybe opened to complete the ventilation.
- Such enclosed or partially enclosed spaces should also be tested for gas during this subsequent ventilation.
- If the tanks are connected by a common venting system, each tank should be isolated to prevent the transfer of gas to or from other tanks.
- Portable fans, where used, should be placed in such positions and the ventilation openings so arranged that all parts of the tank being ventilated are equally and effectively gas freed. Ventilation outlets should generally be as remote as possible from the fans.
- Portable fans, where used, should be so connected to the deck that an effective electrical bond exists between the fan and the deck.
- Fixed gas freeing equipment may be used to gas free more than one tank simultaneously but must not be used for this purpose if the system is being used to ventilate another tank in which washing is in progress.
- On the apparent completion of gas freeing any tank, a period of about 10minutesshould elapse before taking final gas measurements.
- Tests must be made at several levels and, where the tank is sub-divided by a wash bulkhead, in each compartment of the tank. In large compartments such test should be made at widely separate positions.
- If satisfactory gas readings are not obtained, ventilation must be resumed.
- On completion of gas freeing, all openings except the tank hatch should be closed.
- On completion of all gas freeing and tank washing the gas venting system should be carefully checked, particular attention being paid to the efficient working of the pressure/vacuum valves and any high velocity vent valves. If the vents or vent risers are fitted with devices design to prevent the passage of flame, these should also be checked and cleaned.
- Flame arrestors are designed to prevent the passage of a flame back to the tank sand provide protection, particularly in respect of lightning strikes. They must be kept clean and regularly inspected.
- If damaged, they must be immediately replaced. They must not be painted.
- Gas vent riser drains should be cleared of water, rust and sediment, and any steam smothering connections tested and proved satisfactory

39. Handling Liquid Gas Fires on Tankers

Liquid Gas Fires

- The main considerations in fighting a liquid gas fire are the large quantity of vapour given off by the liquid and the considerable heat generated by the flames.
- Liquid gas will normally not collect on deck but may be retained in drip trays - in the event of fire every effort must be made to isolate the source of fuel.
- Dry powder or water sprays are to be used on local fires which prevent access to valves / shut-off actuators. The source of fuel must always be shut-off before the flames are extinguished to prevent a potentially flammable gas cloud forming and being re-ignited down wind or by surfaces heated in the original fire.
- If the fuel source cannot be isolated it is safe to let the fire burn while continuing to cool the area.
- It is not beneficial to use low expansion foam or water for liquid gas fires because the rate of vaporization is increased - Dry Powder is therefore used even though it provides a negligible cooling effect.
- It is essential to provide cooling to the area to prevent re-ignition once the flames are out, until the liquid has dispersed and the area is free of flammable vapour. Cooling is achieved by water from fixed spray systems or hand hoses (with the nozzle in the spray position), or both. Sprays from hand hoses are excellent for protecting fire fighters from the radiant heat of a liquid gas fire.
- The capacity of the dry powder system fitted is limited and unless used very carefully it is possible to waste a large proportion - therefore, it is essential that careful preplanning is undertaken of any large-scale attack following the initial efforts.
- Large quantities of flammable material may [are] be used in the Insulation of Gas Carrier Cargo Tanks and Cargo Handling Systems.
- Care must be taken to protect personnel from the rapid spread of fire, asphyxiation and the effects of toxic products of combustion.

SETION G - Ship specific details

SECTION H- Cargo Emergency Systems and Procedures


Fire
exit