SEAFARERS TRAINING CENTER INC

FIRE PREVENTION AND FIRE FIGHTING

In accordance with the International Agreement of Training, Certification and Watch Keeping for Seafarers 1978 STCW as amended

SCOPE

This course aims to provide the training for candidates in fire prevention and fighting in accordance with Section A-VI/1 on the STCW Code as amended.

OBJECTIVE

The trainee will be competent to take appropriate measures for the safety of personnel and of the ship and to use fire appliances correctly. The trainee will also have knowledge of fire prevention.

ENTRY STANDARS

The course is open to all seafarers and prospective seafarers and should be completed prior to employment on a sea-going ship. All trainees must be certified by a doctor to be in good health.

COURSE CERTIFICATE

Completion of the course and demonstration of competence, a document be issued certifying that the holder has met the standard of competence specified in Table A VI/1-2 of STCW 1978 as amended.

COURSE INTAKE LIMITATIONS

The maximum number of trainees attending each session will be 25 persons.

STAFF REQUIREMENTS

The instructor shall have appropriate training in instructional techniques and training methods (STC Code A-I/6, pa.7). In addition, all training and instruction should be given by qualified personnel.

Course 6.09

TRAINING FACILITIES AND EQUIPMENT

Ordinary classroom facilities and an overhead projector are sufficient for the theoretical part of the course.

For the practical part of the course the training facilities of a local fire brigade be used.

- A large supply of carbonaceous and hydrocarbon fuels (wood, diesel and lubricating oils, etc.).
- 1 foam extinguisher (9 Litre)
- 2 carbon extinguisher (5 kilogram)
- 2 dry powder extinguisher (10 kilogram)
- A shower at the site
- 1 stretcher
- 1 first-aid kit
- 1 resuscitation kit with oxygen / suction unit
- 2 sets of fire- protection clothing
- 2 helmets with visor and neck protector
- 2 fire axes
- 2 safety lines (36 meters long) with snaphooks
- Different type of detectors used on board ships
- Indication of escape routes

The practice will be done on-board ship.
Seafares Training center have Agreement with Ships companies.

TEACHING AIDS

Instructor Manual.
International ship-to-shore fire-hose connection
Demonstration set of self-contained breathing apparatus
Videos

Firefighting at Sea Series:

Part 1 – Fire Prevention (Edition 2) (Code No. 673)
Part 2 – Basic Fire Fighting (Edition 2) (Code No. 674)
Fire Party Operations (Code No. 509)
Safe Air to Breathe (Code No. 431)
Fire Below (Code No. 245)
Fire Fighting on Container Ship. Agreement with fire-fighting company.

TEXBOOKS

A seafarers Training Manual.

BIBLIOGRAPHY

F. Rushbrook, Rushbrook's Fire Aboard. 3 rd ed. (Glasgow, Brown, Son and Ferguson Ltd., 1998) (ISBN 0 85174 659 4)

TIMETABLE
COURSE OUTLINE

COURSE	APRPROXIMATE TIME (HOURS)
KNOWLEDGE, UNDERSTANDING AND PROFICIENCY	LECTURES, DEMOSTRATIONS AND PRACTICAL WORK
Introduction, safety and principles	0.5

Competence 1: Minimize the risk of fire

COURSE	APROXIMATE TIME (HOURS)
Knowledge, understanding and proficiency	Lecture, demonstration and practical work
1. Concept and application of the fire triangle to fire and explosion	0.5
2. Type and sources of ignition	0.25
3. Flammable materials commonly found on board	0.75
4. Need for constant vigilance	0.5
5. Fire Hazards	0.5
Sub-Total	2.5

Competence 2: Maintain a state readiness to respond to emergency situations involving fires

COURSE	APRPROXIMATE TIME (HOURS)
Knowledge, understanding and proficiency	Lecture, demonstration and practical work
6.Organization of shipboard fire fighting	1.0
7.Location of fire- fighting appliances and emergency escape routes	0.75
8. Fire spread in different parts of a ship	0.25
9. Fire and smoke detection measures on ships and automatic alarm system	0.75
10. Classification of fires and applicable extinguishing agents	0.25
Sub-Total	3.0

Competence 3: Fight and extinguish fires

COURSE	APRPROXIMATE TIME (HOURS)
Knowledge, understanding and proficiency	Lecture, demonstration and practical work
11. Selection of fire-fighting appliances and equipment	5.0
12. Precautions for and use of fixed installations	1.0
13. Use of breathing apparatus for fighting fires	2.5
14. Use of breathing apparatus for effecting rescues	0.5
Sub-total	9.00

TOTAL	15.00

COURSE TIMETABLE

PERIOD DAY	DAY 1	DAY 2
1st PERIOD (1.5 hours)	Competence 1: minimize the risk of fire	Competence 3: fight and extinguish fires (continued)
2nd PERIOD **(1.5 Hours)**	Competence 1: minimize the risk of fire (continued)	Competence 3: fight and extinguish fires (continued)
3rd PERIOD **(1.5 hours)**	Competence 2: Maintain a state of readiness to respond to emergency situations involving fires	Competence 3: fight and extinguish fires (continued)
BREAK	BREAK	BREAK
3rd PERIOD **(1.5 hours)**	Competence 2: Maintain a state of readiness to respond to emergency situations involving fires (continued)	Competence 3: fight and extinguish fires (continued)
4th PERIOD **(1.5 hours)**	Competence 3: fight and extinguish fires	Competence 3: fight and extinguish fires (continued)

MANUAL

INTRODUCTION, SAFETY AND PRINCIPLES

The International treaty about Norms of Formation, degree and Guard for the sailors, 1978, amended in 1995, establishes that its strictly essential that all the crew of the ships that sail in international waters, fulfill with the concerning to obtain four basic courses like one of the minimum requirements of formation.

Between the four basic courses it's determined the Prevention and Fire Fighting course that it is demanded to the captain until the last one of the sailors.

The great amount of accidents on board because of human errors motivates the International Marine Organization, the revision, of the agreement STCW 78 that was amended in 1995.

Code STCW95 establishes minimum requirements for all the sailors. The new requirements took effect the 1 of February of 1997. The requirements of basic formation apply, in individual, for those who begin their training after the 1 of August of 1998.

According to the OMI, in February of the 2002, al1 the countries must have fulfilled, but due to a low percentage of countries that supposedly, had fulfilled almost all the dispositions of the amended agreement, six months more of graces were given.

The Participant, once finalized the course will have to:

- Recognize the different types from fires on board
- Know how to choose the appropriate extinguisher according to the type of fire.
- Know the use and the cares the fireman equipment on board
- Know how to procedure with the fixed (permanent) systems against fire on board
- Know the different existing sources of ignition on board and the precautions.
- Know the security norms in the work on board.

COMPETENCE 1: MINIMIZE THE RISK OF FIRE

1. CONCEPT AND APPLICATION OF THE FIRE TRIANGLE TO FIRE AND EXPLOSION

When a fire begins, the fire will continue as long as there is something that can bum. But what causes a fire to start? Why does a fire spread?

The **oxidation** is a process whereby a substance is combined with oxygen. In this process, the normal thing is the release of energy in the form of heat. Sometimes the oxidation is slow, for example the oxidation of the iron or the disturbance of the wood. On other occasions, the oxidation is extremely fast; as for example, in an explosion. A fire is an example of a fast oxidation, energy in the form of light, flames and heat.

All the substances of the universe are c1assitied in one of these three states: solid, liquid or gas (Vapor). The molecules and atoms of solids are directly united and interact between themselves. In liquids, the molecules and atoms are united, but not so firmly. In a gas or steam molecules they can move freely, because the forces of union between them are weak.

To produce an oxidation reaction, it is necessary that the molecules of the body that is going to oxidize must be totally surrounded by oxygen molecules. This it is not possible in solids, or in liquids, since their molecules are packed and it's impossible for the oxygen molecules to enter the interior of the solid or the liquids. Nevertheless, it's very easy that the oxygen reaches to surround completely the molecules of gases. Therefore, only the gases (vapor) can burn.

Nevertheless, when a solid or a liquid is warmed up, their molecules begin to move and when more heat is applied, they move more quickly. Some molecules break their connections with other molecules allying themselves from the body and forming a gas (vapor) so that they are already in an oxidizing condition and therefore, in condition for

burning. If warmed up to the temperature of ignition and a sufficient amount of oxygen is present, the gas (vapor) oxidizes quickly, originating
combustion.

What is to burn?

To bum is the quick oxidation of millions of gas molecules (vapor). When they bum the molecules break into atoms and these recombine with oxygen forming new molecules. During rupture and recombination of the molecules is when energy in form heat and light is given off.

The heat that is given off is "radiation heat" that is pure energy of the same class that is radiated by the sun. It is radiated or travels in all the directions. Part of this energy warms up the substance, that is to say, the fuel. This radiation causes the fuel to give off more gas (vapor) and the temperature of the gas reaches its ignition point. At the same time, the fire warms up the air; this creates low atmosphere pressure, which in turn creates the arrival of more air to the flames. The result of everything is that the gas (vapor) just formed, begins to bum and increases the fire.

2. TYPES AND SOURCES OF IGNITION

Temperature of Ignition:

The ignition temperature of a solid substance, liquid or gaseous is the lower temperature in which that substance will enter into a combustion state without a spark to make it bum. The temperature of ignition varies much according to the different substances. Even for the same substance can vary its value according its presence and surroundings that is to say, in blocks, in dust, in shavings, etc.

For the most common fuels, like the wood, gasoline, etc. the temperatures of ignition begin from 150 degrees C upward.

Oxygen:

The necessary oxygen in the combustions state is in most cases the oxygen that is present in the air.

The air is made up of a numerous gas mixtures, the important ones are: Nitrogen that is present in 78%.

In a fire there is a series of chain reactions and each one of them influences the other, after which each one returns with more intensity than first, and so on. Let us see this in detail.

When a gas is burning (vapor) it develops heat. This heat gives off more gas (vapor) causing the gas to bum. The fuel then produces more heat which gives off and bums new gases, and so on. While there is fuel and oxygen the fire will continue growing, producing more flames.

After a certain time, the amount of gas (vapor) that the fuel is able to produce becomes somewhat stabilized. No matter how much heat is radiated, the combustible can't increase the amount of gases generated. In this way it has reached a maintained burning rate. Normally this process continues until the fuel has been almost consumed. When this happens, les s gas is produced (vapor) and consequently less heat released giving off les s gases which ultimately leads to the fire being contained and finally it is extinguished. If the fuel is liquid, normally it is extinguished completely; if it is solid it leaves remains in live coal or ash form that can continue conserving enough heat for some time.

If the fuel is gaseous, it is generally burned quicker and in a more intense form than solids or liquids, since the heat is not necessary to warm up the fuel and to change it to a gaseous state. All the heat is used in burning more gas, with which the fire is much more fierce and intense. The combustion of gases leaves neither live coals nor ash-gray.

The triangle of the fire:

From what we have learned it is obvious that for the fire to exist the you need three things:

a. Fuel, that vaporizes and burns

b. Oxygen, to be combined with the fuel and;

c. Heat, that raises the temperature of the gas (vapor) of the fuel until the temperature reaches the ignition point. (Flash-point).

The fire triangle illustrates three requirements; it also establishes some facts of importance or rules if one is to prevent or to extinguish fires.

a. If the three sides of the triangle are not present, a fire cannot begin.

b. If you remove one side of the triangle, the fire is extinguished.

The tetrahedron of fire:

The fire triangle in simple form shows the elements that must exist so that a fire can exist.

Nevertheless, it does not explain the nature of the fire. In particular, the triangle does not take into account the concept from the "Chain reaction" that has the reactions between the fuel, oxygen and the heat.

The fire tetrahedron represents better the process of the combustion, since it includes the chain reaction like a fourth element of the combustion. In the tetrahedron, one of letters represents the fuel, oxygen, the third heat, and fourth the chain reaction.

A tetrahedron without the four faces cannot exist, in the same way that a fire cannot exist without the conjunction of the four elements. In the tetrahedron study also the principles before indicated for the triangle stay here more properly modified:

a. If the four ingredients of the tetrahedron are not present, a fire cannot begin.

b. If anyone of the four ingredients is removed the tetrahedron, the fire is extinguished.

Propagation of the fire:

When a fire is fought in a methodical and efficient way it is generally contained to the place where it began. But if left, the fire burns without control and will generate great amounts of heat that will radiate to other areas starting new fires in places where there is fuel and oxygen.

In ships there are many fuels and lot oxygen, the steel bulkheads and covers don't stop the heat radiation completely but if the fire grows sufficiently, the heat can extend to new combustible areas starting new fires.

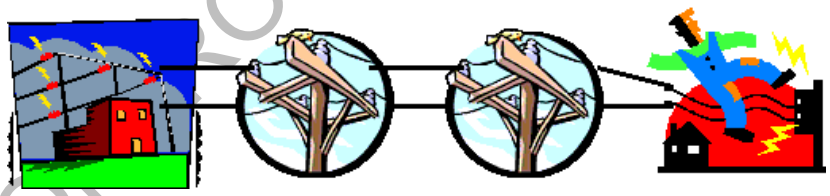
The heat that produces a fire to transfer to other substances is generally caused by one or more of the following the three ways:

Conduction:

Conduction is when the heat transfers through a solid body, for example in a stove, heat is transmitted from the burner to whatever is being cooked through the metal of pots or frying pans. Different substances have different capacities to transmit the heat.

Wood, for example, transmits heat poorly. Metals on the other hand are excellent conductors of the heat.

The majority of the ships are made of metal thus the heat transmission by conduction is always a dangerous possibility. The fire can transfer from one store room to another, from a cover to another, and from one compartment to another, by the conduction system. In many cases, the correct application of water, especially in a pulverized form (foam), will stop or delay the conduction of the heat, since the water will absorb part of the heat. For this the pulverized water is better than the water in a compacted spurt, since the small droplets of water in the foam form and offer a greater surface to absorb heat. In addition to this, using the foam saves water.

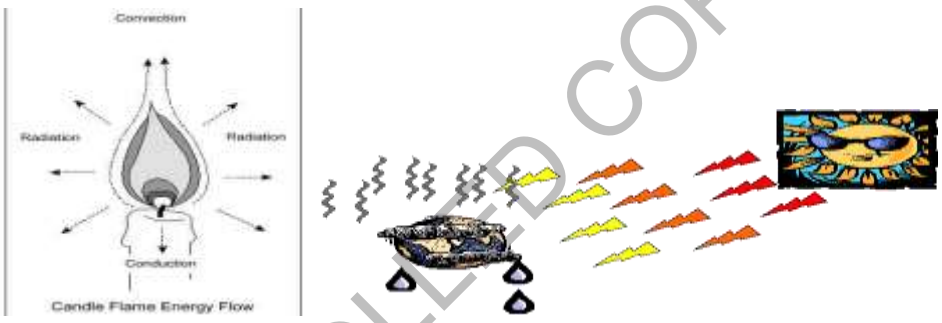


Radiation:

The radiation heat is the transference from the heat center through a space, which lacks any material substance. The heat is come off from the fire equal way that the light, in the air line. When it arrives to a body, part of this heat is absorbed, another part is reflected and another third part is transmitted. The absorbed heat makes increase the temperature of body that absorbs it. An example is the heat of the sun that arrives at the earth through immense empty space between both.

If there are no barriers, the heat is broadcast in all the directions. The broadcast heat contributes to that the fires extend warming up combustible that are within the radiation trajectory.

In the ships, the broadcast heat will make increase the temperature of the combustible material s that are in the proximities of the fire, or even not very small distances, according to the design of the ship. When the broadcast heat is very intense can be difficult to approach the fire. Therefore the people who are fighting against the fire must get dressed in a special way and reduce the heat that arrives to them using the fog from water or other procedures.



Convection:

Convection is the heat transference trough of the movement of a warmed up substance, like the movement of the smoke, of the hot air, of gases warmed up by the own fire or of masses of soot burning that move by the air.

When the fire is confirmed, as usually it happens in the ships, the heat moves by convection according to trajectories more or less anticipated. The fire produces lighter gases than the air that ascend towards the highest parts of the ship.

The same happens to the hot air and the smoke. The space that leaves free these hot products is filled up by a fresh airflow that soon gets to warm up and that like in the beginning, also ascends. When ascending they have separated the sufficient from the fire, they begin to cool off, they get heavy again and they descend. This ascent and slope of the air and other gaseous products of the combustion are known with the name of "**Cycle of convection**".

The heat that takes place in the fire of an upper deck or in a lower deck or transfers horizontally until finding an exit upwards, trough a hatchway or scale. In the route, this heat will be able to set afire all the combustible bodies that find in its step. The ideal would be to have the way to direct this heat towards the atmosphere in the fastest way possible, but unfortunately this is almost impossible in most of the fires.

As soon as a fire is discovered is necessary to try to close as rapidly as possible all the openings of the space where is the fire until it arrives the personnel and appropriate equipment from fighting the fire. In general, it is a good norm of security to maintain closed doors and hatchways whenever they are not being used.

3. FLAMMABLE MATERIALS COMMONDLY FOUND ON BOARD

Solid propellants:

The more common solid propellants are the wood, paper and the weaves. They are abundantly on board in form of canvases, rammer wood, furniture, panels of wood in bulkheads of staterooms and dining rooms, mattresses and clothes of bed, cleaning rags and others. The painting of bulkheads is also solid propellant. About shipment, the ships can take one extends variety of solid propellant in their

warehouses, such as coal, grains, cotton and fibers, other merchandise packed with wood and cardboards, certain scrap irons and many others. Also certain metals can be solid propellants like magnesium, sodium and titanium.

Burning rate:

The burning rate of a solid propellant depends on its configuration. If it is in dust or in shavings it burns much more quickly than if it's in say forms of blocks.

The gaseous fuels are already in gaseous state. In order to bum they only need to mix it with oxygen and have an ignition source. In most of the cases it is very probable that oxygen in the air is very close to the gas. Therefore, the inflammable gases always represent an immediate danger this is explained because when a so lid propellant is divided in small pieces it absorbs much more quickly the heat and vapor.

Special ways of solid propellant finely divided in particles are the clouds of combustible materials, for example, the dust clouds produced by a cereal shipment (wheat, com, soy, etc.). When one of these clouds reaches the appropriate temperature bums very quickly, sometimes causing an explosion like has happened in ships that were loading or unloading grain.

Liquid fuels:

Those that always are on board are. Fuel - oil (to bunker); Diesel engine – oil; lubricating oil; fats; gasoline ; paintings with oil base; painting dissolvent. The liquid shipments fuels are crude petroleum, the products derived from petroleum and chemistry products also the liquefied gases between the incendiary fuels must be included.

Vaporization:

The liquid fuels give off gas (vapor) at a superior speed than solid fuels since the molecules of the liquids are looser than those of solids. In addition to this, liquids can give off gases in a great range of temperatures. For example, gasoline begins to give off inflammable gases at 43 degrees C. This means that the gasoline

is always dangerous to the temperatures of atmosphere. If in spite of this if it is heated up, gasoline gives off gases in much greater amounts.

The liquid fuels heavier than gasoline, are: the fuel - oil or the lubricating oils, they only give off gases if you heat them up. Certain fuels heavier than gasoline like "fuel-oil" and the lubricants only give off gases if they are heated. For example lubricants bums if they are in temperatures of 204 degrees C. It must always be considered that this temperature, although not room temperature, is very low in case of fire, and is the reason why the heavy liquid fuels, reach a flash point quickly especially when they are within the reach of the normal heat produced by a fire.

The gas (vapor) from a liquid fuel is heavier than the air, and turns that gas into a serious danger. The inflammable gas moves looking for the lowest places, and does not dissipate easily and also it moves for considerable distances from the liquid fuel that produced them. If in that displacement it finds an ignition source, like for example, an electrical spark produced by an electrical motor, or by a non-protected switch, immediately the combustion will rise like an explosion.

When a tank of a liquid fuel overflows, or a loss in a pipe or hose takes place, the spilled liquid extends normally over a great area. Immediately it begins to give off inflammable gas that is mixed perfectly with oxygen. If it finds a source of ignition, the combustion is violent and extensive.

Gaseous fuels:

On board usually there is acetylene, used for gas weld, the propane gases and butane that frequently are for domestic uses in the ships.

Definitions and concepts:

Flash point:

The "**Flash point**" of a liquid fuel is the temperature to which the liquid gives off sufficient gas (vapor) to create an inflammable atmosphere upon the surface of the liquid.

By "**inflammable atmosphere**" the mixture is of inflammable gas and air, so that it only can bum when is put under a source of ignition but it cannot maintain a continuous combustion by itself.

The continuous combustion can be maintained when the liquid is heated up to a temperature slightly superior to the flash point, a well-known of "point of combustion".

4. NEED FOR CONSTANT VIGILANCE

To smoke carelessly:

It is the greatest cause of fire in the world, as much on board as on land. There is a very high temperature - like at the moment of lighting cigarettes, cigars and pipes, along with the boxes of matches and lighters.

To smoke is a bad a habit, but for some people it is a habit that they cannot or find it very hard to get rid of and light a new cigarette without realizing that are doing it. Certain people crave so much and feel an urgent necessity to smoke that they do not consider the circumstance or the place where they are, before igniting the corresponding flame. There are many smokers who never have given thought that to smoke is highly dangerous, for their health, and for other many people.

Disposing of cigars, cigarettes and pipes:

The ignited live coals from smoking sources are sufficiently warm enough to burn paper, cardboard, small portions of wood, bed clothes, personal clothes, etc. Whenever a person is going to throw away a cigarette, cigar or pipe it is necessary to use fireproof material or ash trays.

The smoker must make sure that there has been a total extinguishing of the live coal, or better still soaking the water butt.

The ash trays should always be cleared when full and to remove any risk of a small live coal being present the contents shall be placed in a fireproof containers or trash cans.

To smoke in the bed:

It is so tremendously dangerous to smoke in bed that it must be avoided at all times and any place. After a lengthy and tiring day of work, to smoke in the bed can be a great disaster. A fire can begin where the live coal of a cigarette only needs to touch the clothes of the bed and its natural fibers, artificial or a combination of both. Even the smoke given off by this fire can produce the loss of consciousness and asphyxia for the smoker before the fire can be detected.

The risks of smoking in the cabin can only be avoided by following the simple rule: “never smoke in the bed”.

To smoke and to drink (alcohol):

The person who drinks tends to be neglected. If in addition he/she is smoking, it can be highly dangerous. A person who has been drinking gives little importance to a little live coal that falls from his cigarette, cigar or pipe. Or they can leave their butts ignited in any place. Or they leave their cigarette to burn supported on the edge of furniture. All this can be the origin of a fire.

When a person who is carelessly brandishing a cigarette, or very drunk, they must be observed closely and with serious concern. AII the people around him are responsible for his/her actions and must ensure that there is no threat to the ship and the crew.

Areas of NO SMOKING:

The flames or live coals can be very dangerous in some areas of the ship. In these areas it has to be emphasized that smoking is forbidden.

Visitors to the ship, harbor workers, watchmen and any other group of people must also comply with the "**NO SMOKING"** rules. It is very wise to keep an eye on visitors to ensure that they do not contravene the rules and should be constantly reminded of the dangers.

The visiting groups onboard should not be used to fight fires as they may have no knowledge of additional dangers that may be known only to the ships compliment and also their level of traing in such circumstances will not be as extensive. In some cases the visitors will have no knowledge of fire prevention and control.

In general, most of the visiting people will comply with security requests, but if some don't in spite of being warned, the crew member must notify his superior immediately.

To smoke in the holds or tween decks:

To smoke in the holds or tween decks is an invitation for disaster. The main deck is particularly vulnerable for the start of a fire in the holds originating during the loading operations. Such fires can remain undiscovered for several days, when the ship is in high seas. By which time it is probable that the fire has already spread to another hold, making it much more difficult to control and extinguish. To complicate matters, there are ports that do not admit ships with a fire onboard, since they lack the facilities or the experience to fight them.

The best way to fight fires in the ships holds is to prevent them. This can be achieved by implementing and stringently observing safety measures:

a. No smoking at any time in the holds
b. Put abundant warnings of no smoking in the holds and tween deck areas
c. Supervise the holds with greater care and persistence during loading and unloading operations.

To smoke in the engine room or around the boilers:

The engine room of a ship always contains amounts of flammable product derivatives of petroleum, such as the fuel- oil (to bunker), lubricating oil and grease. Even heavier petroliferous products tend to vaporize and mix themselves with the hot air that is in the engine room or boiler room. It is not difficult for an ignited match or the live coal of a cigarette to cause a fire in these areas. Also, a butt that is thrown carelessly or is badly extinguished can cause a fire when it falls on rags stained or impregnated of oil or diesel engine.

The fires in the engine room of the ships are very difficult to extinguish and of course very dangerous for the people who are there. If the fire is large, it is very probable that there is a lost of propulsion power and this will leave the ship just floating, that is to say, without control, which can be extremely dangerous. For all these reasons' it must be prohibited to smoke in the engine room.

To smoke in storerooms and Workshops:

It must be prohibited in spaces such as the storerooms carrying paint, storerooms with wood, carpentry, etc., as they all contain material that can enter in ignition with a match or a thrown cigarette.

Spontaneous combustion:

The spontaneous combustion, also called spontaneous ignition, is sometimes not always taken into consideration on board, which is very dangerous since many of the materials are the most commonly used on board and they can all be a dangerous and spontaneous source of combustion.

An example of a spontaneous ignition that can happen on board easily can be a rag stained and impregnated with for instance vegetable oil or paint left in a comer of a storeroom or some other materials in the engine room. Those areas are hot; and there is little or no ventilation. The oil of the rag begins to oxidize reacting with the oxygen of the present air. This reaction gives off heat. Since there is little or no ventilation, the heat warms up the rag which contains oil with which the oxidation is accelerated and produces more heat and repeats the process in an endless cycle.

After a certain time the rag can be sufficiently hot so that flames start and they can extend to other material s and can lead to the beginning of a major fire. This process can happen, and in fact it has happened, without an external heat source.

5. FIRE HAZARD.

Materials prone to the spontaneous combustion:

On the ship:

Rags impregnated in vegetal oil or paintings can originate spontaneous combustions have already been mentioned. In these cases, the prevention of fire consists mainly of good housekeeping habits and general cleaning and order.

Other materials that normally will not produce a spontaneous combustion but that in certain conditions can are as follows:

- ✓ Wood is one of those materials.
- ✓ Wood like the other substances, must heat up to give off inflammable gases that can bum. On the other hand, most water steam pipes do not need to have a high temperature to bum wood.

Nevertheless, when a wood piece is in contact with a steam pipe or another similar source of low temperature, the effect is that the wood can eventually become vegetal coal that bums at a lower temperature than the wood to which the heat of the steam pipe can set afire. Although the wood transformation to coal can take several days, it is very easy that the process happens inadvertently without anyone realizing until the first signs of a fire arises.

The way to prevent this type of fire is to keep the combustible materials away from the heat sources. If this it is not possible, it is necessary to protect combustible substances, through heat insulating materials.

In the hold:

Many substances that are transported as cargo in ships can undergo spontaneous combustion. The combustion takes place by a chemical interaction of two or more substances. This is very often enhanced with the presence of water and or air.

The International Marine Code of Dangerous Merchandise (Code IMDG) of the OMI, considers dangerous this type of merchandise and offers abundant details of the preoccupations that must be taken to deal with this type of substances; about its packing and separation of from other cargo on board. Also national regulations of certain countries with similar security requirements.

Some combustible loads:

Chlorine reacts if it makes contact with certain metal s or organic substances. Sodium and the potassium react strongly with the water. Some

metals appear in a dust form, like magnesium, titanium, calcium and zirconium and all oxidize quickly in the air especially in the presence of humidity. The result is that it gives off sufficient heat to burn.

Although dry metallic shavings are not prone to spontaneous combustion, but when these metallic particles are stained with oils it is very easy for them to get to produce a spontaneous combustion. This is due to the oxidation of the oil which makes it very easy to produce a spontaneous combustion. It is quite frequent that ships that transport these cargoes, when opening the holds or tanks to unload just by the slight entrance of oxygen is sometimes enough to start a blaze.

The coals can bum spontaneously depending on the content of the humidity, and if they are in particles or blocks, or other forms.

There are many merchandise that can bum spontaneously: alfalfas flour; coal wood; oil of codfish liver; linen c1oths; composed of com flour; fish flour; fish oils; linseed oil; fabrics; oiled; etc.

A good practice to prevent the spontaneous combustions is to separate the fibrous material s of oils.

Electrical equipment and defective circuits:

Electricity is very necessary for many applications, so long as the equipment and the circuits are suitably isolated and protected. Nevertheless, if the electrical equipment is used incorrectly, or conductors become bare caused by the stripping or wear of their insulation, they become serious fire dangers. The electrical equipment must be tested and proved and repaired if necessary strictly following the safety standards and should be done by qualified personnel.

Electrical equipment:

The electrical equipment on board is under constant attack from corrosive elements. The salt air causes corrosion; vibration of the ship can cause the

insulation of the wires to break and cause part of the electronic equipment to fail. The result of this, the electrical equipment or their conductors can produce sparks that are excellent sources of ignition if in close proximity of inflammable gases.

The electrical equipment that is used on ships needs to be of special design it is necessary to provide regular maintenance. It must only be used only for which it has been designed. It is best to consult whenever there is doubt over its use or operation.

Cable and Fuses:

The insulation of electrical cables, especially cables and connections that are used in machines; portable tools. Generally after time, become fragile and they can break, or if badly used by personnel unsuitable work also the vibration of ship can cause the insulation to strip leaving cables bare allowing contact or arc with any other metallic object side. If two cables without insulation make contact, a short circuit takes place. In any case a spark takes place. In most cases it will have sufficient energy to initiate combustion if there are inflammable gases.

Fuses housed in breakers trip boxes. When repairing unfortunately or at least sometimes a bigger fuse is used or an unsuitable breaker is used. The danger arises when more current is allowed to pass through the circuit other than the design value and heats up the wires of the circuit. There have been cases where all the insulation begins to bum and along with it, the inflammable materials close by.

In order to prevent fires by these causes it is necessary to replace cables immediately where they have lost their insulation. It is also necessary to replace fuses and breakers with the correct current rating values.

Electrical overloads:

Sometimes, in places where there is a single switch they take off individual connections for applications like radios, fans, it touches tapes, plates, heaters, television, etc.

This can be dangerous because the cables of each switch are calculated for a predetermined electrical charge. If it exceeded this value the cables heat up and can bum, radiating heat to combustible materials that can be close starting a fire.

Electrical lights without protection:

The heat that is given off an electrical bulb can bum combustible materials that are in contact with the bulb. There have been fires in ships due to curtains of synthetic material made contact with the bulb and initiated an ignition, with serious consequences.

In the outdoors covers, there are moments when the bulbs are protected by a plastic cover or canvas, which is an excellent measurement of protection when bulbs are dull. But if the cover is left, it is very probable that the heat of the lamp can bum the cover.

Similarly portable lamps that are used to illuminate work in an area of little light. These portable lights give off heat. Also they can fall, especially when there is bad weather, so that the filament of the center can cause a spark.

Electrical motors:

Electrical motors are a frequent cause of fire on board. When electrical motors don't receive proper maintenance or if they work beyond their capacity or life utility, it is likely that they start to give problems.

Electrical motors regularly need inspection, tests, lubrication and cleaning. If one of the coils short circuits or has a mass derivation this can be enough to cause the bearings of the motor to overheat.

This gives it an ignition source, and depending on the circumstances can cause the start of a major fire.

Static electricity:

Static electricity is a source of ignition which is of significant importance, especially in ships tanks. It is particularly dangerous because it is difficult to know when there are electrical charges with sufficient ambient conditions to produce a spark.

The static electricity is generated by the accumulation of electrical charges originated by the friction of two substances. In the ships tanks the substances that can graze creating friction are products that are transferred during loading and/or unloading against the side, pipes, valves, pumps and tanks.

The best way to prevent the accumulation of electrostatic loads is to electrically connect the facilities of the wharf and the ship.

Some products, like for example, the fuels for the aviation reactors generate more static electricity than others. If there are water particles in suspension in the product, the possibility of the existence of electrostatic sparks grows. A good practice of security is to begin the operation of loading or unloading slowly to allow the water to settle at heart of the tank.

Another security practice is not to use metallic material s for taking of samples of the cargo, or to know its level in the tank, the possibility that a spark can jump from metallic object within the tan. You must use a non-conductive material such as plastic.

Another security practice is not to take samples from the tank until 30 minutes have passed since the end of the operation. Ibis time allows the possible static electricity to dissipate.

Finally, the static electricity is generated very easily if the cargo enters the tanks making contact against the bottom and walls.

Engine room:

The engine room is a very vulnerable zone to electrical irrigations. Water dripping from a water pipe coming into contact with electrical equipment and instruments can cause severe short circuits.

Even more serious can be fuel dripping onto hot zones or electrical equipment.

The best way to prevent this type of risk is by constantly monitoring and correcting any leaks from fluid pipes.

Batteries:

When batteries are loading or unloading, they give off hydrogen, which is a highly inflammable gas. Mixing with air an amount of hydrogen that goes from 4.1 % to 74.2% in volume is potentially explosive. The hydrogen is lighter than the air and therefore it tends to increase. If there is no ventilation, the hydrogen is concentrated in the highest part of the enclosure where the batteries are held. If a source from ignition takes place it will produce an explosion immediately.

The best way to prevent this risk is to ventilate the area where the batteries are, as well as making the area No Smoking and not to allow machines that produce sparks or excessive heat.

Storerooms and deposits:

It is not unusual on board a ship, when the provisions are received either by haste or hardship they are kept in storerooms and deposits in a "provisional" form, with the intention of making the distribution of these provisions at a later time. Unfortunately, there are occasions when that later moment never arrives and ship puts to sea with its equipment and provisions badly packed. When the ship begins pitching and rolling, the objects fall, and can sometimes break circuits or electrical cabinets, or even pipes. All this disorder is an excellent invitation to start a fire, especially because of the nature of most of the things that are kept in the storerooms of the ships.

The best remedy is to be always sure of packing provisions properly. Never pack in haste and orderly storeroom is important.

Galley:

In most ships the galley and its next dependencies are always very occupied places. Usually there is much activity, with several people working in a reduced place;

there are flames or at least abundant heat, combustible fat accumulations and other materials. In summary, the kitchen is always a dangerous place.

Energy for cooking:

The most habitual energy in the galley is electrical. Sometimes the stoves are fueled by diesel oil, this however is less frequent, in small ships and it is normal to cook with butane gas or propane.

The electrical equipment in the galley is subject, to the same precautions as other electrical equipment, although its easy contact with water which it makes it more dangerous.

When liquid fuels are used, all the personnel of galley must be very focused on possible fires that can be caused by pipes and connections, either by bad handling or by damage caused by elements that may fall on them or by other causes. If a loss of fuel is discovered, it is necessary to close the entrance valves immediately, and to notify the failure so it can be repaired by competent personnel before resuming its use.

Stove:

The stoves are a double danger. Its heat can produce a fire in the kitchen. Its fuel can increase a fire originated in another place. The kitchen personnel must be very careful when they work near the stove. If not it is easy to burn a cloth, towels, rags or paper. Never deposit materials upon a stove. When the ship is at sea personnel must always use bars or similar to make sure that the stove doors cannot fling open.

The stoves must always in good condition with the side lights in order so that it can be seen from a distant spot that the burners are connected. They must be equipped with safety equipment to prevent any fuel leaks onto the burners without combustion.

Frying Pans:

Always used in the galleys of ships and are another possible source of fire. It is necessary to use them with precaution and supervision. The frying pans must be placed to fixed parts of the ship preventing them to slip when the ship rolls or pitches. Food must never be put especially if in the process of defrosting in hot frying pans.

The pan's small area must not be tilled too much so that the oil can overflow and spill. Never leave a frying pan whilst cooking without having someone monitoring the operation.

Cleaning of the Galley:

The activities in the galley, as we said before, generate abundant fat and they are next to violent heat centers, everything required to start a fire. The best way to prevent this happening and avoid a fire is to carry out regular cleaning and keeping in order wastes and trash.

Sometimes there are excessive fat accumulations in the stoves, especially in the bell of smoke, filters and extractors. If for any reason these areas ignite, it is easy that the fire will propagate through the extractor and into other sections.

Fuel on a ship:

The fuel for the ship is stored in double tanks and in other tanks, under the engine room. These tanks can store thousands tons of fuel, according to the size of the ship and its trip. The most used fuels on board are: fuel oil: bunker C; and the oil diesel engine. Some like the fuel oil bunker C are very heavy and vicious combustibles that need to heat up before being able to burn.

Its temperature of an inflammatory level is about 66 degrees C and the temperatures of ignition oscillate between 370 and 407 degrees C. The diesel oil engine does not need preheating. Its flash point is of 43 degrees C and its temperature of ignition is 260 degrees C. During the fuel loading there is a special danger of fire, all will be ok if no failures or errors are committed but it is necessary to remember that the fuel gives off gases which are highly inflammable.

One risk is the overflow of the fuel from the tank. In this case, the fuel rises from the tank via a pipe and leaves by the ventilation tube, before scattering by the cover. Pay attention that there are no overflows by taking whichever measures are necessary, verify constantly the operation is being carried out correctly, and repeat continuously the fuel calculations and do not leaving the operation. If in spite of all this the tank still overflows, it is necessary to start up a routine fire prevention situation to control any flames, sparks etc, to avoid spills to the sea. These exercises should be part of the safety procedures on board. Other risks are the fuel lines and hoses that are being used. If the lines are small, the pressure of the liquid within the pipe tends to make the combustible dangerous and gasifies quickly with the consequent danger of ignition.

The flights in the line of fuel are especially dangerous if are next steam pipes, motors, electrical, electrical panels and similar equipment.

Well areas:

Fires in wells are caused by an excessive petroliferous product accumulation coming from fuel lines and pipes. These products vaporize easily and gases accumulate within the space inside the wells where they are mixed with the oxygen in the air. From this moment, a dull match or a discarded ignited cigarette butt carelessly thrown or any spark can start a fire. Fires in wells propagate very quickly and are not easy to control. In order to prevent these fires it is necessary to

inspect the wells frequently and carefully. If a lot of fuel is observed then that normally means that there is some fuel lines that need to be located and repaired.

Repairs that require Welds and cuts by heat:

These repairs are very frequent on board and they are always very dangerous since the flame of gas weld or the arc of the electrical weld reaches the 3000 degrees C. In addition to the heat, the works involved with welds and cuts produce many sparks that are very dangerous.

In these works fires can be caused through the following reasons:

- ✓ Don't anticipate an area free from fire risk especially in the immediate vicinity, without the monitoring for several hours after the repairs are finished.
- ✓ If you do not remove all the combustible materials of the immediate areas or have not protected them or isolated them from the heat.
- ✓ If you weld near masses of dust or combustible gases.
- ✓ If you locate equipment close to combustible material s in the proximity of the works.
- ✓ Don't take precautions with the welding equipment to avoid flames or sparks in an uncontrolled way.

Safety measures in cases of welding or cuts on board:

- ✓ Observe carefully the international safety procedures.
- ✓ Observe carefully the national and local safety procedures.
- ✓ Observe carefully the company safety procedures.
- ✓ Use only welding equipment in good working order.
- ✓ Welding equipment must be handled by authorized and trained operators.

Plan carefully the development of all the work, safety measures, warnings, etc., under the supervision of the person in charge.

COMPETENCE 2; MAINTAIN A STATE READINESS TO RESPOND TO EMERGENCY SITUATIONS INVOLVING FIRES.

6. Organization of shipboard firefighting.

Personnel of the firefighting team must undertake other specific tasks. Some of the members of the group must act like investigators. Under the protection of the water of the hose, they must investigate the possibility of the existence of trapped personnel, conscious or unconscious. Other members of the group must investigate if the fire has extended to other areas, identify in detail the fire area or act as messengers if necessary.

Protective clothing:

If a fire has going for a certain amount of time, it is possible that it will reach temperatures of more than 500 degrees producing toxic emissions with strong concentrations of smoke and gases. The members of the group that are fighting the fire cannot continue their firefighting if they are not sufficiently protected against these dangers. They have to refire or otherwise they can be affected by gases and be burned. If they themselves become victims, the fighting capacity against fires becomes less.

As a minimum, each member of the group of the hose must be equipped with proper firefighting clothes (trousers and coat), rubber boots, helmets and gloves. These clothes will protect them against the heat, hot water and the steam.

The appropriate equipment for the fireman will be explained in more detail.

Respiratory protection is obtained by artificial respiration equipment. The team members that handle the hoses must be trained in the use of this

equipment and they must know their limitations in order to have confidence in their capability to protect them in a hostile atmosphere.

In certain situations, the first team to attack a fire may not have enough time to put their protective clothing on or to obtain the artificial respiration apparatus, since they have had to commence the offensive immediately to prevent that the fire spreading and getting out of control. If this situation occurs, it is a case of using one's common sense.

It would be bad practice for a team to abandon a position when firefighting except in cases of serious difficulties. It is probable that their starting position can be maintained for a certain time without wearing all the protective clothing, that time might be short, but vital. Nevertheless, if it is not possible to control the fire, nor possible to hold position, the group must fall back and back away from the fire to a safe place.

The lead man who handles the nozzle, whilst backing away from the fire must use a fine spray but wide jet to block the flames as he moves away from the heat. The team must continue backing away until finding a position where they can resist the heat without protective clothing.

Meanwhile, it is essential that a reinforcement group that are wearing the appropriate clothing and have the necessary equipment including breathing apparatus continue with the operation effectively replacing the group that initially attacked the fire.

Team of firemen;

In agreement with the arranged in SOLAS, 1974 (Amendments of 1981) the firemen equipment will include:

Individual equipment will consist of:

- ✓ Protective clothing, of a material that protects the skin against the heat. The outer fabric will be impermeable
- ✓ Rubber gloves
- ✓ A hard helmet
- ✓ A safety lamp with a minimum of 3 hr operation life
- ✓ An axe

An approved respiratory apparatus that could be:

- ✓ An anti smoke helmet or an anti smoke mask provided with a suitable air supply. An independent respiratory apparatus that works by compressed air and whose cylinders have at least a capacity of 1,200 liters of air or another independent respiratory apparatus that can work for a minimum of 30 minutes.
- ✓ It is important to have on board a sufficient amount of spare parts for the apparatus.
- ✓ Each separate respiratory apparatus will have a non- flammable safety cable of heat resistance material and will be sufficiently long enough to be tied by a hook to a harness or to a separate belt.
- ✓ All the ships will have on board at least 2 sets of firefighting equipment.
- ✓ The firefighting equipment will be kept ready for immediate use and shall be stored in easily accessible locations and, if there is more than one set it will be located next to the first set.

Chart of obligations and consigns in cases of emergency:

It is an obligatory document demanded by the International treaty for the Safety of Human Life at sea (SOLAS) that must be displayed on a ship in several visible points. It will be easy to understand, and it will give instructions illustrated in

all possible cases and will be written in a language that all the crew can understand.

The chart of obligations or duties is a list of all the specific tasks that each member of the crew has to do during emergencies, and also it shall describe the various signals that will be sounded should the ship be in an emergency situation.

The Notice of obligations & duties consists of several columns. The first column, generally to the left contains the relationship of the crew to the ship. It will not give names since these can vary, but numbers and positions of the crew are generally used. It is the obligation of all the crew members to find out the number that corresponds to his & her position in the chart of obligations.

Even though the charts of obligations & duties can be different from one ship to another, in general terms all of them contain similar information. We will now give a brief description of the information contained in a chart of obligations & duties for a typical cargo vessel.

One column will show the description of the crew, it appears in a column with the distribution of the functions and the signals in case of fire. In the case of fire the signal is a succession of whistles or bell of duration of not less than 10 seconds followed by a continuous alarm sound.

The old signal in this emergency was 3 short whistles with the whistle of the ship, followed by 3 long bursts with the sound of the alarm.

The signal for fire drill exercises consists of a pre announced warning to all the crew and the signals will be the same as the emergency fire alarm.

In the distribution of functions of each one of the crew appear their specific tasks to make in the case of fire emergency. Thus, and only as an example, the 2nd. Officer has the obligation to place the documentation and the money of the ship in a safe place and he reports to the 1st. Officer. If there are injured personnel, he will practice the necessary treatment and report to the 1st. Officer.

Another example, a crewman covers all the air intakes, closing covers and grills of the ventilation system and any other opening by which airflow can arrive at

the fire. He is also assigned to be in charge of the portable extinguisher No. 1 under the orders of 1st. Officer.

One more example. The Mess attendant has the following tasks. He will take to the place of the fire extinguisher No.8. He will also close the doors and openings of the upper decks.

In the chart of obligations & duties are also routine instructions that must be followed in case of a fire is and also the procedure how to use C02 in the engine room along with the other requirements for operation against fires.

Also appears in the chart of operations are the specific tasks and the signals in the case of the ship being in danger, such as grounded, collision, or in a case of very bad weather etc.

Also there is another column where the specific signals appears and duties in case of abandonment of the ship. Finally, the last column registers the distribution of the crew in the dinghies, giving the specific tasks and the number of the corresponding boat.

Obviously, all the crew members must be totally familiarized with their specific obligations in case of emergencies and know them without having to resort to read them when the emergency arises.

Personnel who handle the hoses:

When firefighting:

One of the most important units in fire fighting is the hose team. Ideally, to operate efficiently, there needs to be four personnel to handle the hoses during a fire. However, it is recommended that at as a minimum there should be least two people handle a hose of 38mm (1 ½ inches) and three for hoses of 64 mm (2 ½ inches).

The key man for the fire hose operations is the man who operates the nozzle, because it his he who control s the type of spray and its direction. In many cases the same person will have to make decisions on his own often before the leader of the team can offer assistance.

The man who is in charge of the nozzle must have the training and the discipline to give confidence to the people who have to accompany him, who have to handle the trailing hose as the team advances towards the fire and so that the water is directed towards the appropriate places of the fire.

It is important that this responsible position must be assigned to a crew member who has received special training in firefighting.

The person who handles the nozzle must also be totally familiar with the ship and all its cargo.

Immediately behind the man who handles the nozzle is the support man. This man supports the weight of the hose and absorbs part of the reaction of the pressure from the spurt, so that the man who handles the nozzle is free to attack the fire. This important support enables the person with the nozzle to be able to stay in position whilst fighting the fire. The support man and the man with the nozzle must act in perfect coordination.

The other members of the team that handle the hose are positioned throughout the length of the hose to take up or pay out the hose as the leader maneuvers around the fire. Special teams are normally utilized to protect areas around the engine room. This team should be familiar with the engine room in addition, this crew will probably have been in the proximity of the fire when it started and will therefore know the cause.

For the same reason, the personnel of the hose team should be those that habitually work in the engine room.

Advance with the hose:

When fire alarm has sounded, the hose closest to the fire must be moved as close to the fire as possible and then open the valve of the hydrant. Without water, the hose is very light and very easy to handle. Once the hose fills with water and along with the pressure of the flow it becomes heavy and hard to handle. The members of the hose team get fired because

of the weight of the additional water and especially when they have to go up or down stairs or through the corridors.

In addition they have to use apparatus for artificial respiration, which increases the work rate of the body and personnel consume more oxygen than in a normal situation.

The hose must be handled in the following way. The man at the nozzle and his support man take the first section of the hose and advance towards the fire. The third member of the hose team maintains the central section of the hose and advances in a synchronized movement with the lead pair.

The fourth member of the hose team remains at the control post of fire to open the hydrant and make sure that the water supply is not impaired. When the man at the nozzle is in position, he requests the water valve to be opened. As the water tills the hose, the third and fourth member of the hose team must be prepared and hold any oscillation, at the same time they should check connections to see that the water is flowing properly along the line. If there are any leaks, they can tighten the connections. When the water arrives at the nozzle the lead person must open it slightly to allow any air that may be contained within the hose to escape. The hose must be closed when the water begins to flow allowing the pressure to build and is then ready for the operation.

During firefighting exercises all the hoses must be unfolded and settled as if a real fire is taking place. The training must be as realistic as possible. The teams that handle the hoses must simulate real practices and should include taking hoses towards holds or, to pass them through the corridors, up and down stairs and as many difficult positions as possible.

Appropriate use of the water jet produced by the hose:

The form, in which the jet of water shall be applied, depends of the situation of the fire. The man who handles the nozzle must know the type of jet of water that he has to use and when he must use it according to conditions of the fire.

Necessity of training:

SOLAS recognizes the necessity to make periodic exercises and drills against fires, as we have already mentioned. But it is not only an obligation imposed by an agreement; it is the application of the principle that says: "Better safe than sorry." It is possible that emergencies are not frequent, but when they happen; justifies all the effort of the preparation and the training. For that reason it is necessary that all the crew take with the maximum interest, application and greatest effort the necessity to prepare properly before possible emergencies occur on board. If these never arise, nothing has been lost. But should it be the case it does happen and the crew is not properly prepared, the loss in lives and material damages can be enormously high and outside all justification.

Services of watchmen on board:

An important function of the service is the monitoring made by crew of the fire detection and alarm apparatus, that is to say, constantly checking the automatic system. The greatest difference between the manual and the automatic system is in the monitoring.

Duties of the watchman on board in the case of fire-fighting:

Although a watchman on board can have other specific duties, we have talked only about to the relations with the detection and fire alarm.

The watchmen must receive detailed instructions of their duties and carry them out diligently. It is necessary to instruct them on fundamental procedures to

activate the alarm in case of fire, and notify a senior officer even without seeing the fire, and has only been detected by the presence or smell of smoke.

There have been occasions in which precious time has been wasted when the watchman has walked to the navigation bridge to report the alarm instead of activating it from a fire case.

7. LOCATION OF FIRE –FIGHTING APPLIANCE AND EMERGENC ESCAPE ROUTES

Fires in ships are very difficult to control due to the great variety of fuels that can be found on board and the many products of combustion that can be found on a ship can obstruct the operations against fires.

In addition to this, the design of the ship complicates enormously the extinguishing of the fire. For example, when the fire is located in a department in a hold, it is surrounded by bulkheads and covered by steel, this fire is difficult, if non impossible, to reach, to fight and to ventilate.

Also it can be impossible to reach the material s that are burning in the lower part of a hold storeroom since it would be necessary to remove everything that was packed during the loading operations making it practically impossible, especially if the ship is at sea.

An important question is how must the crew attack fires in a predetermined location on a ship?. Part of this answer has been addressed in the previous chapters and in part it will be given in the present chapter. But there will always be a part that will require initiative and the knowledge of the crew in each specific case. A collection of answers that can be used for all the ships and different cases does not exist.

Each ship and each case has individual characteristics which will require all the knowledge and experiences of the crew to resolve.

Activation of the alarm:

Any crew member who discovers a fire, or the indication of fire, must activate the alarm and report the fire immediately. A delay in this can cause a small fire to turn into an inferno. Once a fire takes hold the heat intensity extends very quickly.

All fires must be reported to superiors, even small fires that are extinguished without assistance required. Each fire must be investigated to discover what the defects were or fire faults that have caused the fire so that procedures can be investigated and if necessary corrected so that they do not occur again in the future.

Location of the fire:

The crew member who activates the alarm or reports fire must be sure to give the exact position of the fire, providing all the details to be able to locate it perfectly. This is important because, firstly, it confirms the existence and location of fire and alerts the ship's fire fighting crew to fire emergency. Second, because it provides information relative to fire type of fire and subsequently to the type of extinguishing agent.

Also because fire exact location of the [¡re indicates fire necessity to close fire ventilation systems. Finally, because fire physical position provides information as to the hatchways that must be closed to isolate the fire.

Measures of precaution:

If flames have been seen, the [¡re is effectively located. Nevertheless, if it is only smoke detected, the fire can be beyond a bulkhead or fire door of a compartment. Therefore, before determining where exactly is the fire, it is necessary to take into account certain precautions.

Once the fire had been located, the door does not have to be opened until a loaded hose is arranged. A fire that is burning in a closed space consumes the oxygen that is within that space. The fire looks for more oxygen and an open door represents a generous possibility of oxygen provision with which the fire will reactivate.

Procedures against fires:

As we said previously, the fire travels from a space to another by means of the radiation, conduction and the convection of the heat. In most of the cases, this process extends fires laterally (towards port and starboard) and also upwards. In some situations

fire gets to be transferred downwards through conduits or trunks of stairs due to the conduction. Even, live coals burning can come off from upper parts and fall extending the fire elsewhere.

Evaluation of the fire:

As soon as possible, it is necessary to determine the characteristics of the fire using the following criteria:

- ✓ Fire Class (material that is burning).
- ✓ More appropriate extinguishing Agent.
- ✓ Methods for the most advisable firefighting method.
- ✓ Methods to prevent the extension of the fire.
- ✓ Human Resources and equipment that are needed against fires.

Communications:

The communication with the person in charge, generally the Captain of the ship, must be established by means of radio, telephone or by messenger. The communications with the firefighting group must always be available, in working order and maintained. The messengers can be most effective in situations where telephone lines may be destroyed by fire and in addition it is normal that the firefighters are moving constantly and their position can be relayed to the Captain via the messenger.

A good radio system is probably the best form of communication.

Attacking the fire:

The attack must begin as quickly as possible to gain immediate control and to prevent the fire spreading before extinguishing.

Frontal attack:

In fire frontal attack, fire firefighters advance to fire immediate area of the fire and directly apply fire extinguishing agent to fire base of the fire. Normally the

fire fighting teams have little difficulty in getting to the fire. However it can happen that if the fire gains intensity, fire heat, the gases and fire smoke increases making fire approach much more difficult and hazardous.

Indirect attack:

The indirect attack is used when it is impossible for fire firefighters to reach the base of the fire. This is generally the case when the fire is in fire lower decks of the ship. The success of an indirect attack depends in being able to contain the fire from spreading.

One of the techniques consists of making openings in the space where the fire is and insert a tube or similar and inject in that tube the extinguishing agent to reach all the set afire compartment.

Ventilation:

Ventilation is fire action by which fire products of combustion that may be confined within fire ship are dispersed into the atmosphere. Most of the fatalities of a fire are not caused by the flames, but by the asphyxia produced by gases of the combustion and the lack of oxygen. Even, before the smoke and fire heat become visible the carbon monoxide gives off fatal effects, and other poisonous gases around the ship. Crews that may be sleeping can be choked by these gases and unfortunately resulting often with mortal results. Nevertheless, if it is possible to ventilate the fire properly, the smoke, heat and fire gases are dispersed removing fire danger to the potential victims and other fuels that may not have been implicated in the fire.

The ventilation path can be vertical, seeing that the gases and smoke being a product of combustion disperse towards the atmosphere through openings located immediately above the fire and forced upwards by the action of the extinguishing agents and the fire.

The ventilation can also be horizontal by means of openings to windward and leeward of the fire so that airflow through the spaces can be created where there is a fire.

Also a combination of horizontal and vertical ventilation can exist .On other occasions it is necessary to resort to mechanical ventilation using activated ventilators that create the necessary airflows to expel the gases and the smoke produced by the fire.

Rescue:

Rescue of trapped personnel is one of the most important points of all the operations against fires. The rescue can be the first operation or in other cases it is necessary to delay it due to adverse circumstances.

The decision to enter and rescue a person can't be taken according to fixed rules; it has to be studied for each individual case. The decision takes into account the difficulty of protecting lives and that of safeguarding the ship.

Return to normality:

The return to normality starts immediately after the main fire has been extinguished.

But, be warned the return to normality can be a dangerous phase. Statistics show that in many cases that most serious accidents occur to people during this phase.

The return to normality consists of two phases: investigation and final extinguishing; cleaning and bailing.

Investigation and final extinguishing:

The objectives of the investigation are to find possible hidden live coals that are outside ordinary visual reach. This is an important exercise and must be treated as seriously as when the fire was being fought. The personnel who make the investigation must use all their senses: ear, sight, tact and sense of smell. Also they must check all the fire starting capabilities through conduits, trunks, corridors, stairs, etc.

All the materials that could be disastrous in the event of a fire such as mattresses, packs, small boxes, must be opened and examined since many of these materials can burn again.

Cleaning and bailing:

At the same time it is necessary to clean all the ashes and products that didn't completely burn during the fire. It is also necessary to correct all the conditions that may be uncertain, for example, tables with nails, cables that are hanging, loose equipment, etc.

The bailing is also an important part of the operation against fires of a ship, since the masses of accumulated water can seriously reduce the stability of the ship.

Controlled fire:

A fire can be considered as controlled when:

- ✓ The extinguishing agent has been applied to the base of the fire and has been able to penetrate the most internal part of the fire, beginning to cool it.
- ✓ The main body of the fire has been darkened. In this condition the fire cannot generate sufficient heat to set alight a fuel that may be close to the fire.
- ✓ The firefighters have examined and protected all the routes where a fire can spread.
- ✓ The preliminary search of victims has been completed.

Conclusion of the firefighting operation:

Before the firefighting operation can be declared completed, the Captain of the ship must have the safety of the ship and its crew confirmed by the head of the firefighting group, who has been at the scene of the fire and that essential procedures have been carried out, such as:

- ✓ A complete examination of all the fire area to make sure that:
  - All the routes surrounding the fire have been examined and controlled.
  - The necessary level of ventilation has been achieved and that all the gases and smoke have been ventilated into the atmosphere.
  - The area where the fire occurred is safe and it is possible to enter without artificial respiration equipment.
  - A complete examination has been made of all the fire affected materials.
  - A guard has been deployed in case of the fire igniting again. A crew member or more if the fire was major must be present in the area where the fire took place.
  - All the equipment used in the firefighting has been recovered. The used hoses have been returned to their storage point, or replaced with new. All the suitable material s have been collected, cleaned and dried for storage.

The portable extinguishers have been recharged and placed in their respective sites. The equipment for artificial respiration have been cleaned and arranged for re-use. A damage control list has been initiated, to audit a complete examination so as to determine the damage that has resulted through the fire to the people and the ship.

- A count of all the personnel to establish the identities of possible victims that may have occurred

Critic of the operation against fires:

After the operation has been completed and all the firefighting equipment has been recovered and restored to good condition, a critical view of the operation must be made. The view does not have to be very formal. In fact it can be adapted to make the critical assessment whilst a cup of coffee is being made. It is best to air this critical view before returning to normal obligations onboard.

The critic can begin by congratulating the crew who completed the extinguishing of a fire on the ship that is at sea. Which procedures were a success and a reason for a satisfactory conclusion.

Nevertheless, while the details of the operation are still fresh in the minds of all, it is necessary to consider certain questions. How could it have been done better? More important, how will it be possible to prevent the same type of fire recurring?

If another fire occurred tomorrow, ¿How Hill it be fought?, ¿Would it be the same way? Can the same successful with less fatigue and less physical stress to the firefighters and with less damage for the ship?

While all this is begin discussed, the commander of the firefighting team must be animate so that suggestions and recommendations are formulated and they must be written down. These ideas can be included in a new plan for fighting fires on board.

Fire in corridors:

When a compartment catches fire through a fire in a corridor, is essential to reach that compartment. The water from the fire hose must go towards the centre of the fire to lower the flames in the corridor before directing the hose appropriately as to the state of the fire. This is achieved by advancing as close as possible towards the flames and staying in a bent position. The nozzle is opened and a high speed water jet is used. The jet of water must be moved up and down so that the water bounces along the bulkheads and ceilings and falls on the flames. This pushes the heat and flames away from the man in control of the nozzle so that he can continue advancing until he completes his objectives.

When water bits the hot flames and gases, water steam is created. This steam along with the smoke produced by the fire makes the visibility is very bad. At this time a reinforcement hose must be engaged so as to cover as quickly as possible the position of the initial hose which is being used against the fire. The back up hose can be used to protect the first hose or can also be used to douse the fire if it is need a great volume of water to control the situation.

Fire within compartment:

In order to reach a fire that is behind a door, a fully prepared hose must be positioned, with water pressure and without air, outside of the compartment and just in front of the door. Next, the door is opened on1y enough to insert the nozzle. Using the door to protect himself, the man who leads the team must sweep the nozzle from side to side so that the compartment is fully doused with water.

The man who has the nozzle and the man who supports him must stay bent as much as possible, in order to allow that the heat, the smoke and the steam to pass over them. After a little time the door can be opened a little more. If the conditions allow it, the fire hose handlers must enter the compartment and advance until they get to the heart of the fire where they can attack with sprayed or solid jet of water.

8. Fire spread in different parts of a ship.

- In engine room, waste bins used for storing oily rags must have lids (covers). Oily rags should not stay lying around or stuck at unnecessary places. Receptacles with covers should be provided at each floor and on both sides.

- High pressure fuel oil pipes should not be tightened to control a leakage while the engine is running. Also, oil shouldn't be taken in to turbochargers during operation.

- Short sounding pipes should be kept shut with plugs. Never should they be left in open position for the sake of convenience. Cases have been reported wherein oil has spilled out from these short sounding pipes leading to accidents.

- Loose pet cocks /small cocks on common rail pipes should be checked for.

- Exhaust leakages and steam leakages should be promptly attended.

- Ship's crew should be careful about galley fires, especially by keeping electrical equipment in good order. Senior officers should keep an eye in the galley when provision is being received because this is the time when galley remains unattended for a long time.

- One of the patent methods of fire prevention is effective and regular fire patrol. There is no method that can beat physical monitoring.

- Fire caused by cigarettes is still one of the most common causes of fire. All care should be taken to dispose cigarettes (using self closing ashtrays) and never should one smoke in bed.

- Fires have also caused during loading and unloading of cargo such as coal. For this reason, ship personnel must always discuss the characteristics of the cargo and preventive methods to be taken during safety meetings and weekly drills.

These are some of the main points one needs to consider for a safe environment on ship. This list might not feature all the methods to prevent fire; however it does provide a brief overview of how things are to be handled on board ships.

9. Fire and Smoke detection measures on ships and automatic alarm system.

A fire detector is a device that produces an alarm signal when it detects a fire in the protected area.

The alarm is designed to alert the people in charge of the safety and security of the ship, for example personnel on watch, and in the vicinity of a fire outbreak, will alert all the crew.

It is essential to discover the fire as quickly as possible, because it is much more easy to confine, to control and to extinguish, before it reaches great proportions. For that reason, a good fire detection system and prevention procedures are fully understood and maintained by the crew. It is always the best element for the protection against fires on board.

The detection systems on board are carefully arranged, and in case of a fire, a visible and sonorous alarm is relayed to the Bridge and the Engine room. The team that receives the alarm will confirm the existence of the fire and its location on board. The detection equipment is usually located in the bridge and sometimes, in the C02 room. In the engine room there is usually only a bell or whistle.

When receiving a fire alarm, the officer in charge on the bridge will activate the general alert for fires so that the crew quickly responds and takes up their positions and functions to fight the fires according to the procedures for fires on board. In all the cases, the captain will investigate the origin of the alarm. If the

alarm is authenticated he will order the containment, control and extinction of the fire according to the established procedures, under the direction of the captain.

If it is a false alarm, its necessary to investigate its cause and correct it. In any case, it is necessary to verify the correct operation of the detection system and the alarm to check its operational state.

They are different systems for the detection of a fire; the most used, are the followings:

- ✓ **Automatic systems for the detection of fires**
- ✓ This type of system is by integrating the following sub systems:
  - Normal Source, for energy provision
  - Emergency Power Supply
  - Control unit of fire detection system
  - Alarm and Fire detectors

Normal source for the provision of energy:

The normal source of energy can be the ordinary generating plant of the ship by means of the distributing panel or it can consist of a power source formed by batteries. In this last case, the batteries must solely be used for the system of detection and fire alarms.

Emergency power:

It can be the emergency generator unit of the ship with an independent circuit or it can be batteries. There are situations in which the batteries are double the capacity. In this case, one of fire batteries is always in load and serves as emergency battery.

Control unit of the fire detection system:

It consists of a protected metallic box and an inner panel which contains the fue alarms, the alarms of operational failures and those that lack energy. The warning devices generate visual and acoustic signals simultaneously.

The visible signals are the following:

- ✓ A red light indicates that smoke or a fire exists.
- ✓ A blue light indicates the existence of failures of operation in the system.
- ✓ A white light indicates that the electrical energy is connected.

This unit also has a switch to pass from normal power feeding to emergency. It also has the necessary protections such as: fuses or circuit breakers (breakers). If the source is of batteries, the load equipment can also be found in the unit.

Alarm and fire detectors:

The fire detectors detect the heat existence, smoke, flames or other indications of the fire and produce the corresponding signal that is received by the generating equipment of alarm. The visible alarm consists of one or more red lights in the control unit and in the other positions. The sonorous alarms consist of whistles or a fire bell. Generally the fire bells are between 15 and 20 cm. in diameter.

When a fire has been detected, the visible alarm (red light) remains lit and the sonorous alarms remain sounding until the silencer of the bell is activated, but this does not extinguish the red light. This light is extinguished solely by the manual readjustment of the system. The modem alarm systems allow at the same time to receive fire alarms from diverse points without interference between them.

The failures in the provision of electrical energy to the detection system and a fire alarm alert, by the sound of an alarm, in that case it will appear as a luminous signal. The failures in the operation of the system, for example the rupture or electrical disconnection of one or more cables of the detection system wail be noticed because the blue light lights up and sounds the same alarm as that of an energy failure. There are certain pieces of equipment that registers the failures of operation fire alarms.

Detectors activated by heat and set temperature:

They are those that give off a signal when the temperature of the sensor element reaches a certain value which is set prior to operations. It is correct to say that this type of detector activates only when their sensorial element and not the air that surrounds it, reaches the fixed value temperature. Therefore, when a detector of this class activates, the temperature of the air that surrounds it is higher than the temperature to of the sensorial element.

The values of the temperature of the air next to the detector and the temperatures that activate them are:

- ✓ **Ordinary Values:** For temperatures less than 38 degrees C
- ✓ **Intermediate Values**: For temperatures between 38 and 66 degrees C
- ✓ **High Values**: For temperatures above 66 degrees C

The most common detectors of this class are: Of laminates bi - metallic; of disc bi - metallic; of thermostatic cable; of metallic cable; of fusible metal; and of expansion of liquid. AII of them act by the action of the heat on their components, which produces expansions.

Detectors of increase in temperature:

This type of sensor detects the changes in temperature and not the static value. They activate when the temperature rises quickly rather than a set value sensor. For example, if one of these detectors is set for an increase of temperature of 8.3 degrees C per minute and the temperature happens to rise 40 to 46 degrees e in a minute, the detector will not activate. However if the change of temperature had been of 45 to 55 degrees e in a minute, the detector will activate.

Its main advantages, in comparison to the fixed temperature detectors are as follows:

- ✓ Slow increases of temperatures do not activate them.
- ✓ They can be used in areas of low temperature, for example cooled warehouses and likewise in areas of high temperature, for example, boiler rooms.

The disadvantages are:

- ✓ They can generate an alarm when an elevation of temperature takes place for a different reason, for example, by some heating apparatus, or by heated metals in its proximity.
- ✓ It cannot be activated by fires that elevate the temperature of the air slowly, for example, the fires of cotton bullets.

The most used types of sensors increased temperature are: thermoelectric and fires. They are also detectors that are the combination of the two that have the advantages of each system.

Smoke detectors:

They take continuous samples from the air and give off an alarm when smoke is detected. The samples of the air are routed from the protected spaces to the detector by means of appropriate pipes. Sometimes there is a ramification of such pipes to the navigation bridge, where the officer in charge can detect, by the color and scent, the presence of smoke and therefore suspect a fire. **The detectors are of several classes**: photoelectric; ionization; bridge, resistance and cloud camera. In all of them the effect of the presence of smoke in air is measured through an electric current within the sensor.

Detectors of flame:

They are designed to recognize the characteristics of all types of flame: intensity of light; pulsation frequency (tremor); and radiation energy. Its is not frequently used on board since it presents certain disadvantages such as, the flames must appear right before the detector, and not to the side; the flames may grow dark caused by smoke; they can also be activated by other luminous sources other than flames, giving rise to false alarms.

Manual systems for detection of fires:

The manual systems for fire detection also have the two power supplies of the automatic systems, normal source and the emergency source. They also have a control unit where the alarms are received and the audible and visible signals of general alert. They also rely on necessary points of networking, in the form of boxes or panels located in different areas from the ship.

Most ships use the automatic systems and manual working together. When a crew member discovers a fire he/she must immediately press the corresponding alarm in the manual system. This will serve to confirm the signal produced by the automatic system or to demonstrate its failure.

The manual systems count on a series of alarm points, or distribution boxes in different areas of the ship. In general they are placed in corridors, stairs and spaces where people meet, and with the idea that a person who is moving away from a fire will pass a fire alarm case. They must be painted in red, and will contain the instructions for fire fighting operation in a clear manner. Usually they are protected by a clear glass panel with an inscription such as: **rompase en caso de fuego** or also in English, **break glass in case of fire.** It is important that all the crew know the procedure to activate the alarms in the case of a fire onboard the ship.

10. Classification of fires and applicable extinguishing agents.

Portable equipment:

The portable equipment is very useful for a first attack immediately after the detection of a fire.

Unfortunately the portable equipment generally has a limited capacity of action. In many cases the duration of the contained extinguishing agent can be les s than a minute.

The action against fires with portable equipment must be complemented and supported with hoses and a continuous provision of extinguishing agents. However, a crew member who is using a portable extinguisher cannot prepare and use a hose against fires.

For that reason it is necessary that, along with the use of the portable equipment, the alarm alerting the crew must be sounded as soon as the fire has been discovered so that the rest of the people can prepare the necessary support equipment.

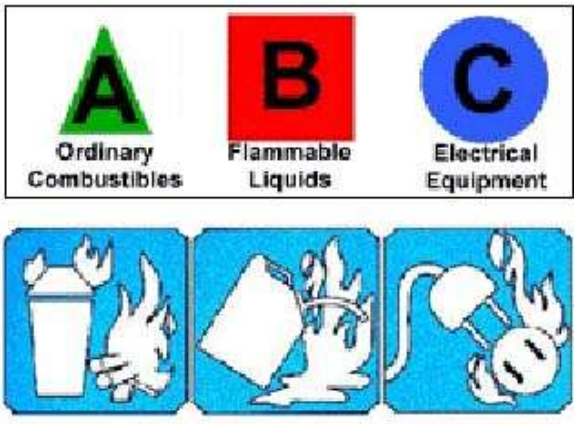
Portable Extinguishers:

There are different classes of portable extinguishers that are frequently seen in the bulkheads of the ship, in the walls of the buildings and other points. The characteristics of the extinguishers can be known by their classification. The classification of the extinguishers does not always agree. In general, the extinguishers are classified with capital letters, Arabic and Roman numbers.

The letters indicate the fire class in which that extinguisher can be used. For example, if the letter "A" is shown it means that that extinguisher can only be used in fires of class "A". If the extinguisher is classified under letters "AB" it means that it can be used in fires of the class "A and/or B ".

The Arabic numbers indicate the extinguishing quality, and the capability to extinguish fires the type of fire indicated. It is a relative numeration. For example, if an extinguisher appears with the number "4 A", That means that it has twice the capability to deal with a class "A “fire, than a "2A" extinguisher. This numeration doesn't make reference to the size of the extinguisher.

The Roman numbers can also appear in the extinguishers and gives indication of the size of the extinguisher. They go from 1, the smaller one; to V the biggest one.



General rules for the use of the portable equipment against fire:

- ✓ When a fire is discovered:
  - Give the voice "Fire in? "(Wherever it may be) Giving the relevant information to the location of the fire.
  - Activate the closest fire alarm
  - Verbally ask for help, in a serene, calm, and especially in a clear manner.
- ✓ If the fire in the judgment of the person who detects it, is small, and it can be put out with the portable extinguisher, **he must follow the rules**:

  - Never pass through a fire searching for an extinguisher, because of the possibility of becoming trapped by the fire.

  - If to attack a fire it is necessary to enter in a compartment, it's also necessary to have an escape route from the fire.
  - If the opportunity to use the extinguisher fails, the compartment must be abandoned immediately, closing the door behind you. The person

who detects the fire must remain in place to give the information to the personnel who will be fighting the fire when they arrive.

Water extinguishers:

They are several kinds of extinguishers that use water as an extinguishing agent but there are other products contained within the extinguisher to force the water out.

SOSA extinguisher - Acid

For example within some extinguishers there is a SOSA solution of bicarbonate (0,7 kg) and water (9,5 liters), for an extinguisher of class ZA(n). In the upper part there is a small cylinder that contains 0,23 kg of sulfuric acid. When the extinguisher is vertical with its cover upwards the sulfuric acid cannot be mixed with the watery solution.

The extinguisher is transported towards the place of the fire, carried by its handle. At the place of the fire, the mouth is pulled down; with which the acid is mixed with the watery solution generating carbon dioxide (C02) and creates pressure (about 10 $kgcm^2$) which impels the water with force out of the cylinder through the nozzle.

The spurt of the impelled water goes towards the base of the fire; fan the spurt from side to side, wetting as much material as possible that has caught fire. This particular extinguisher is exhausted in les s than a minute.

The extinguishers of - acid, must stay loaded to temperatures above zero degrees centigrade, in order to avoid the water to freeze. These extinguishers must be loaded at least once a year and whenever they have been used or unloaded. Annually their components are examined for signs of corrosion. During this examination it is recommended that the components of the extinguisher are washed with fresh water.

On fire extinguisher it will be written fire date in which fire load took place, and sometimes also the name of fire company and fire name or fire initials of fire

person who loaded it. Every month fire extinguishers need be inspected to ensure that they are fuII and that fire nozzle is not obstructed.

Water extinguishers operated by gas cylinders:

One of the most common types is the "2 A" (II). It has fire capacity of 9,5 liters of water and a reach of 10 o 12 meters. The extinguisher is full of water and or an antifreeze watery solution. The cover contains a small cylinder with C02 to pressure. When fire cylinder is perforated, fire pressure of fire C02 forces the water out.

This extinguisher is taken to the place of the fire using fire handle located in fire cover. Arriving at the fire perforated fire cylinder of C02 and fire water will be forced out. The spurt must go towards fire base of fire fire and remember to fan all the materials that have caught fire. The time of unloading is less than a minute. It is necessary to unload fire enfire extinguisher completely since there is no valve to close the exit of fire spurt.

This extinguisher must be inspected annually and you must weigh fire pressure cylinder of C02 to verify possible gas losses. If it is not in good conditions or it has lost too much gas, confirmed by fire weight it must be replaced, following the instructions of the manufacturer.

Also it is necessary to inspect the nozzle and the hose to verify that they are not obstructed. In order to load these extinguishers, fill with water until a level indicated on the extinguisher is reached.

A variant of this type of extinguisher is that, instead of having a cylinder of C02 to impel the water, it has air or nitrogen to pressure (about 7 kg. by cm2.) in the upper part off the extinguisher.

Foam extinguishers:

The foam extinguishers have a similar appearance to fire one described previously but have much greater range of putting out fires. One of most common is fire "2 A": 4B (II). This means that fire extinguisher can be used in fires of class "A" and those of class B. It has a capacity of 9,5 liters. Its reach varies of 9 to 12 meters and its time of unloading is something les s than one minute.

This type of extinguishers are filled with two solutions that stay separated inside the extinguisher until it is used. These solutions are commonly called solution "A" and solution B. These letters do not have anything to do with the classes of fires.

This extinguisher is taken to the place of the fire in a vertical position with the cover upwards. When preparing to unload the contents it is reversed, putting the cover downwards with which the two solutions are mixed producing liquid foam and C02.

The C02 acts as impelling and fills the bubbles of foam. The liquid foam expands to 8 times its initial volume. This means that an extinguisher of 9,5 liters produces about 70 liters of foam. The foam must be applied smoothly on the fire.

This can be done by directing the spurt towards the back of the fire allowing the foam to set on the fire surface. The chemical foam is quite stiff and flows slowly. Therefore the spurt must be directed from several angles to completely cover the materials on fire.

Sometimes it can be applied in the shape of a thick layer like a blanket; allowing it to flow and cover the burned surface.

In temperatures less than 5 degrees C the foam extinguishers can freeze. Once they have been activated it is necessary to unload them completely since

there is no closing valve. The maintenance consists mainly of annually discharging the foam contents, carry out an inspection, recharge and clean.

Carbon dioxide extinguishers:

The C02 extinguishers are used fundamentally in fires of class C and class B. The most current sizes of the portable extinguishers range from 2 to 9 kg. Not including the weight of the extinguisher.

The C02 is stored in the extinguisher in a liquid form and approximately to a pressure of 70 kgcm2. The extinguishers of 6,8 kg have the classification of 10B:C (ll). The reach of the C02, when it's projected from the cylinder, is about 2 meters. The duration of unloading varies between 8 and 30 seconds according to the size of the extinguisher.

The extinguisher is taken to the fire in a vertical position. The reach of the C02 is very small, so the operator must approach close to the fire. Extinguisher is placed on the floor and the safety pin removed. The discharging is controlled, either by opening the valve in the upper part or by activating a release lever.

The operator must hold the hose with the hand, never the metallic diffuser. When the C02 is exhausted from the cylinder the extinguisher expands quickly and cools off immediately. The diffuser cools off enough to cause freezing problems if somebody is touching it. When an extinguisher of C02 is going to be used in a closed space, the operator must be cautious against suppression caused by the expulsion of oxygen; therefore it is necessary to use artificial respiration equipment.

The diffuser must go initially towards the base of the fire and very close to the operator. Unload the diffuser backwards in front of the fire. At the same time the operator must move toward the fire very slowly. Sweep the flames on the surface of the fire with what looks like "snow" from the extinguisher.

Whenever possible, fires outdoors must be attacked from windward side. This will contribute to move the heat away from operator. In general terms, the C02 extinguishers are not very effective when there is wind, since the mass of C02 does not stay sufficient time on the fire to obtain its extinguishing effect.

When there is a class C fire the unloading of C02 must go towards the origin of the fire in the case of electrical equipment. The equipment must be first disconnected to avoid electrocution.

The C02 extinguishers do not need to be protected against freezing. Nevertheless, they have to be stored in temperatures less than 50 degrees C to maintain a level of safety from its own internal pressure.

The C02 extinguishers must be inspected frequently by a qualified person, in order to recognize possible damage and to make sure that they have not drained because of failures in its water tightness. They must be placed under detailed maintenance and they must be weighed. If there is a loss of more than 10% of its weight it is a signal that the C02 has escaped. The recharging operation must be made by the manufacturer or specialized companies. Also a C02 extinguisher must be recharged after being used even if it has only been partially used.

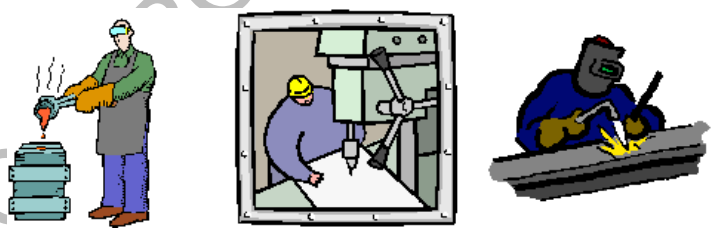
FIRE CLASS A



FIRE CLASS B

FIRE CLASS C

FIRE CLASS D



. Dry Chemical agent's extinguishers:

The dry chemical agent extinguishers are on the market in different sizes and with different products. All of them are c1assitied as "BC" and some of them can be classified like "ABC".

Dry chemical agent extinguisher:

Operated by gas cylinders:

Their sizes vary from 1 to 13 kg. They can be tilled with any of the 5 types of extinguishing agents for this c1ass. In order to impel the dry chemical agent, a small cylinder with inert gas is used. The reach is calculated to be between 3 and 10 meters. The extinguishers weigh about 4,5 kg. and last only 8 to 10 seconds. The bigger size can last up to 30 seconds when fully discharging.

The extinguisher is transported to the fire vertically and with its cover upwards. When prepared to use on the fire, remove the safety pin and press the perforation handle. The propulsive gas then impels the extinguishing agent out through the nozzle. The exit flow is regulated by means of the handle that is next to the nozzle at the end of the hose. The unloading of the contents is directed to the base of the fire beginning at the edge. The spurt must fan from one side to another with fast movements to sweep the fire from the fuel. If it is used outdoors, the fire must be attacked from the windward side whenever it is possible.

The initial unloading does not need to go towards the materials on fire if less than 1 or 2 meters, because the pressure of the flow can scatter the material that is on fire. If the gas cylinder is perforated it will become pressurized, but should the extinguisher not be used or it is used partially, the gas surplus will probably disappear after a few hours. Therefore, it is necessary to recharge the extinguishers after use although they have not been fully used.

Dry chemical agents; extinguish fires of class B by the rupture of the chain reaction with no or very little effect of cooling, the possibility of a revival of the fire always exists if the surfaces that burned remain hot. Therefore, some other extinguishing agent like a reinforcement or support must be used until all the sources of ignition are eliminated.

The dry chemical agents can also be used with water, and some of them can be used with foam. Some other variants of these extinguishers are

in circulation and instead of using an external cartridge, the impelling pressure is contained within the extinguisher.

Dry dust extinguishers:

The dry dust (not to be confused with dry chemical agents) is the only extinguishing agent that can be used in the case of metal fires, class D. The most common of these extinguishers is the extinguisher of 13,6 kg, operated by a gas cylinder for pressure. This extinguisher externally looks like the dry chemical agent extinguisher. One of the differences is that the reach of a dry dust extinguisher is reduced to about 2 meters.

In order to operate a dry dust extinguisher, firstly remove the nozzle from its support and press the perforation handle. This allows that the impelling gas, which is usually C02 or nitrogen, to force out the dry dust from the extinguisher. After directing the nozzle towards the fire and controlling by the handle that is in the end of the hose to direct the dry dust to the metal surface that is on fire.

The operator must begin the application of the dry dust from the maximum distance. By means of the regulation handle it is possible to control the amount of dust that is jettisoned to the fire to create a heavy dust layer on the fire surface. The operator must be careful to avoid breaking the crust that forms when the dust is deposited on the surface.

Sometimes great amounts of dry dust are needed to extinguish a small fire of metal. When the dry dust takes a chocolate color tonality it is signal that there is a hot spot where the dry dust layer or crust is not sufficiently thick enough and therefore it will require more dry dust be applied.

The dry dust can sometimes arrive in a box for its application with a shovel. In this case it must be deposited smoothly so that a crust or a heavy layer begins to form on the object on fire.

Semiportable equipment for fire extinguishing:

A semi portable system for fire extinguishing is equipped with a hose that can unfold towards the fire. The other components of the system are fixed, or

located in determined places. Normally this equipment is too heavy to be moved easily and is therefore provided with wheels for transportation or movement.

The semi portable systems pro vide a great amount of extinguishing products. This allows that the operator to mount an attack on a fire, for a longer duration than the totally portable systems.

One of the main disadvantages is that the area protected by the semi portable system is limited to the length of the hose connected to the system.

The extinguishing agents are applied in the same way to the fires, as described for the portable extinguishers. The main differences with respect to these extinguishers is the reach, which is slightly more from the nozzle to the fire, and of course, a greater amount of extinguishing agent.

The semi portable systems are arranged in certain areas like they are fixed systems. Whenever it is possible, the fire is attacked initially with a semi portable system. If with this system the fire is controlled or the fire is extinguished then it is not necessary to activate the fixed systems.

Semi portable system of C02:

Is generally used in the engine room or spaces that contain electrical equipment. The system is made up of one or two cylinders of C02, a hose of between 15 and 20 meters, a diffuser for the discharging of C02 and a valve of control for opening and close.

The system is activated manually, and uses a control lever which is mounted in the upper part of the cylinder of C02. If the system consists of two cylinders, it is only needed to operate one of the handles, since the pressure of the first cylinder opens the control valve of the second cylinder so both can be used.

The general procedure when using the C02 cylinders is as follows:

- ✓ The safety pin is removed and activates the control lever of the cylinder.
- ✓ The hose is then taken to the fire.
- ✓ The handle is opened with the valve of the diffuser placed towards the fire.
- ✓ The spurt of C02 goes to the edge of the fire.

- ✓ Continue the spraying until all the material s that are on fire are covered with the extinguishers contents.
- ✓ In order to stop temporarily the flow of C02 the valve of the diffuser is closed to do this the handle is turned backwards.

Semi portable system of products

This semi portable system consists of a storage tank where the extinguishing agent is contained and one or more cylinders which contain a gas or nitrogen for pressure. Also included is a rubber hose and a nozzle with a control valve.

The system activates by pulling the head of the mechanism at the opening in the upper part of the nitrogen cylinder. Some systems can also be activated by means of a remote control lever.

When the system has activated, nitrogen flows towards the cylinder where there are dry chemical agents before it is forced through the hose and out of the nozzle. The hose must be extended totally to obtain a continuous flow of extinguishing agent.

Semi portable systems of foam:

They can be found in many different places on the ship. The foam generator system is used along with the general water system against fire. It is an effective method and an efficient system for foam production but it requires more operators than the semi portable systems that use other extinguishing agents.

One of the most habitual types of the portable systems of foam generation are those that use a foam nozzle along with an entry tube for the foamy substance. This is joined to a normal hose that it is connected to the general water system for fires.

The air enters through an aspiration element that is put in the hose. When the air, the foamy substance and the water are joined, the foam that is discharged through the nozzle.

COMPETENCE 3: FIGHT AND EXTINGUISH FIRES

11. Selection of fire-fighting appliances and equipment:

The main target when firefighting is fast control and the quick extinction of the fire. This is only obtained, in most cases, when the fire is attacked with a sufficient amount of extinguishing agents and by using the correct techniques.

The fixed systems for fire extinguishing are those that provide the extinguishing agent in sufficient amount and therefore allow a greater guarantee in the fight against fires.

In accordance with the spaces that they protect, the fixed systems for the fire extinguishing can be as follows:

- ✓ General water System
- ✓ Automatic System of water sprayers
- ✓ Gas System (C02 and halogens).
- ✓ Foam System

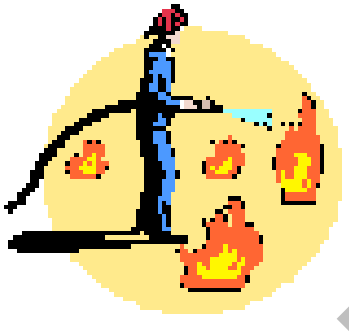
In the ships tank the inert gas is used as an excellent path for the prevention of fire. The study of the inert gas system corresponds to the training course for the crew of **"Tankers".**

General system of water:

It is required that all ship installed this system although other systems against fires. It consists of:

- ✓ Aspiration of sea water
- ✓ Pumps against fires
- ✓ Collector or main pipe
- ✓ Ramification pipes
- ✓ Hydrants
- ✓ Valves
- ✓ Hoses, nozzles and lances

- ✓ International Connection of the pipe against fires on the ship to the earth network.



Pumps:

The pumps used against fires must have less capacity than the maximal capacity of the pumps that drain wells. In general they should be capable to pump I80-m^3/ hour of water, with not less than 25 m^3/ hour for each pump separately.

The number of pumps should not be less than 2 or in the case of passenger ships [3]. The sanitary pumps, ballast pumps, and well pumps or those of general services can also be used as fire pumps whenever they are not used for their normal usage.

In certain cargo vessels an emergency fire pump is required; its capacity is not less than 40% of the joint capacity of the other pumps.

The fire pumps must be equipped with a safety valve that is released when the pressure in the pump exceeds approximately 8 kg /cm^2 over the nominal value of the pressure.

Collector or main pipe fire pumps:

In general terms there are two types of configurations of pipe in the general fire prevention system:

Collector line:

The collector is a pipe that runs from the bow, generally at the height of the main deck. From the collector are extended horizontal vertical pipes ending up in the corresponding hydrants and complete with the necessary valves. The

disadvantage of the unique linear collector system is to provide service to an area of the ship which is beyond a point, for example, where the collector has undergone a breakage or a failure.

Ring collector:

A ring collector consists of two sections of linear collector pipes, parallel to each other, and connected together at a point near the bow and another at the stem, forming a complete ring. The horizontal and vertical feeder pipes are connected to both sets of collectors. In this configuration, any point of the collector which may have undergone a breakage can be isolated and the water is available at all the parts of the ship.

The diameter of the collector will be sufficient so that the maximum water volume established for the pumps, can reach to all the parts of the ship. The normal diameter of the collector is between 100 and 150 mm and the feed pipes between 37 - 64 mm.

The minimum pressures of the water in the collector, with the equipment working normally, for "cargo" vessels is 2,75 kg cm2, although no fire hydrant will have a water pressure above which that cannot be controlled effectively by the firefighter using the corresponding hose.

Positions against fires:

The set formed by a fire hydrant with its corresponding valve, the hoses and the nozzles are known with the name of "**position against fire**".

It is important that all the equipment stays in good condition and in a suitable place, that is to say, next to the position where fires may break out. The hoses and their nozzles must be visible and easily accessible.

They must also be situated in places so that they can be connected quickly and easily into service. Nevertheless, this accessibility makes them vulnerable to

damage and abuse. One type of abuse is to use hoses to wash down the hatches or for other menial tasks of the ship.

Another abuse occurs on occasions when moving heavy loads by hatch covers and the pipe or valves receive blows. In addition to this corrosion of the metallic parts of the system can cause the valves to be immobilized as well as the effect of the inclemency and the contact with fats, additives, paint, etc., that produces a premature aging of hoses.

There are other bad practices with these fire systems, for example, to take "a loaned" hose from a position to tight a fire, which means that one hose will not be functioning during the time that is away. Also, due to negligence of the people who handle hoses, sometimes they are dropped on their connections, which produces deformation or damage in these connections making them defectives or unusable.

All the crew members, and no matter their rank and responsibility on board, must make an effort to protect the total fire system and to maintain it in perfect state, avoiding all non authorized use.

Every week a visual inspection of the positions for firefighting must be done making sure that all the equipment is in its place and reporting it immediately if there are problems. Firefighting exercises, that periodically must be made on board, the use of all the different hydrants must be programmed so that approximately every two months they have all been proven "Fit for Purpose" In this way you also reduce the risk of corrosion accumulation.

Whenever an opportunity arises (for example sailing by rivers, lakes, the Gatun Lake, etc.) it is highly recommended that a thorough rinsing with fresh water is carried out on the firefighting system.

Hydrants:

The number and the distribution of the positions against fires on board will be so that at least two water jets not coming from the same hydrant, and one of them delivered by a hose of one piece, can reach any part of the ship.

The positions are usually numbered with a numeration correlative to the object to make the perfect identification and control of each one.

Fire hoses:

These are the flexible pipes through which water is transported from the hydrant to the fire. They are of canvas or another suitable material with dressings of rubber or another synthetic material. The hose has two metallic connections at each end, male and female both connected. The female connection is always connected to the hydrant and the male heads always to the fire.

The hoses are the weakest parts of all the system because they can be damaged by facilities or structures and also by incorrect use, for example, pulling them through hatch covers or and the abrasive action of the dust, fats, paints or other substances. The hoses can be cleaned with fresh water and a neutral detergent using a soft brush. The hoses must be inspected visually every week to prove that they are in good condition and tested with the normal pressure of the water for the fire system.

When packing the hoses in their support it must be avoided that the hose is always folded in the same place so as to avoid creasing and debilitating the hose at these points. The most used diameters of hoses are: 64 mm (2 inches) for hoses that are used outdoors and 38 mm (I inches) for hoses that are used in closed sites. The length of each hose section is generally 15 meters.

Storing of hoses:

There are different modalities to pack and to gather hoses. It is an operation that must be done carefully to avoid deterioration to the hoses. The main steps to gather hoses are:

- ✓ To review and to clean any fat, paint or fuel that may have come into contact with the hose.
- ✓ Inspect the enfire length and the extension of the hose to verify that it is totally dry. Humid hoses, even partially, are not to be packed.
- ✓ Verify that the female connection has its rubber seal.

If in the firefighting system the hose is connected to the hydrant:

- ✓ Connect the female connection to the male thread of the hydrant.

The hose without sharp folds is packed, arranging folds so that it is possible to unfold them easily so that you can quickly take the nozzle to a possible fire.

Connect the nozzle to the male connection of the hose, verifying that the connection is tight.

- ✓ Make sure that the nozzle is in its support or in a position that the hose can unfold easily. There are two ways to fold a hose:
- ✓ In the form of a flat letter "S" when the hose is packed in a box.
- ✓ In form of "curved S" when the hose is housed in a semi circular metallic support.

If the hose does not connect directly to the hydrant, or it is a hose of additional spare part or, collected after verifying that is clean and dry and it has been connected to the female connection, it is stored by way of the following procedures:

- ✓ The hose is placed extended in straight line.
- ✓ Begin to coil the hose from the point where the fold is coiled without pressing too much weight on the hose.
- ✓ Once the hose is coiled the hose is tied, without pressing too much, with a rope yarn or thread of candle.
- ✓ The male connection must be left protected from possible blows from underneath the female connection.

Nozzles and lances:

In previous chapters certain aspects of this equipment has been mentioned, as well as their functions and operation. It is only possible to indicate that the lances, that are also called applicators, are strong metallic elements but they have not been designed to use them in substitution of bars or metallic handles when it is required to force a door or to force a cover that is obstructed.

If they are not used in the correct way, it is almost certain that they will be damaged and they will inflict a lost of efficiency in their fundamental function and that is to project water.

The applicators are coiled in the nozzle and act in one of the following ways (solid spurt, fog or closed).

Bifurcations

It may be better sometimes to have two 38mm (1.5 inches) hoses than a single hose of 64 mm (2.5 inches.) For this are used bifurcations. The most common is the one in the shape of a "Y".

In a "Y" bifurcation the water entrance has a female connection of 64 mm (2 inches) that is connected to the hydrant. The two male connections of 38 mm (1.5 inch) are what the hoses are connected to.

Each branch takes its own valve with a quarter of a turn. When the small hand of the valve is in a parallel position with the flow of water, it means that the valve is open. If the small hand is perpendicular, the valve is closed.

It is necessary to have present a ramification that multiplies the number of hoses but divides the pressure in each one of them, so there will be no doubt that there is sufficient pressure. It is always better to decide on a single hose against fires with ample pressure instead of have two hoses with insufficient pressure.

Keys:

The keys are special tools that are used to tighten or to unscrew the threaded connections of hoses.

The keys must be the of the same measurement as these connections. When buying new hoses it is necessary to also specify the size of the key that fits

the connections. The ideal situation would be that all the connections of hoses could be tightened and loosened enough by hand with no need to use the keys, but there are times because of the effects of corrosion or effects of blows they are too tight and to relax them it is necessary to use this tool. Also there are occasions in which tightening manually is not enough to prevent leaks through the connections thus loosing pressure and more reason why it is necessary to use the key.

International connection to land supply:

If the ship is in port and a fire is declared, it would be very advisable to have outside back-up in case of a fire. It can be obtained from the facilities on land or another ship in the proximity. In order to avoid the difficulties of connection between the system of the ship and those of other systems that can help, for example by difference of the respective types of connection or its size. It is therefore a standard in all ships that the same type of equipment size is used.

There is an international connection for these types for fighting fires from the land whilst in port. This connection can be portable and set up on the land, either on the jetty or similar and is connected to the land supply. In turn the hoses can be connected to the ship and its hydrants to be used in the case of a fire.

12. Precautions for and use of fixed installations.

Fixed systems of fire extinguishing by water aspersion to pressure:

Some spaces of the ship, like those of the engine room and other parts of ships, are protected against fires by means of the fixed systems of fresh water aspersion to pressure. The purpose of this system, in addition to the extinction of possible fires, is also to protect the structure of the ship and to limit the extinction of the fire and control the amount of produced heat.

The system of sprayers activates automatically by the heat generated in the space where it is and it is deactivated manually by means of the corresponding

valves or by the exhaustion of the contained fresh water in the tank. The main components of this system are:

Pipe:

The pipe runs from the fresh water tank that contains the water that is used by the sprayers until such time as the hoses can be brought to tight the fire. It is designed so that a minimum of 5 liters/ minute is provided to the protected areas.

Valves:

They control the water in the areas of concern.

Sprayers:

They are designed so that when they activate they allow a flow of pressured fresh water to form into one thick conical curtain of water large enough to cool the area corresponding to each sprayer.

Activators:

The activators have a double function; they are the elements that make the water discharge from thy sprayers and at the same time perform as fire detectors.

The activators have a sensor mechanism to measure the heat in the air and when the temperature reaches a certain value it activates automatically and discharges the water from the sprayers. They consist of a valve in a cover form that controls the exit of the water. This cover has two parts connected together by means of an alloy of a low point of fusion. When the heat in the area is sufficiently high enough the activator's connections become fused and the covers opens through the force of the water.

The activators are set so that they work with temperatures between 68 and 79 degrees C. In those areas where in normal conditions they can have higher temperatures, such as the laundry, the temperature sensor can be increased.

Each section of sprayers, when activated to help control a fire, will give an optical and acoustic alarm automatically indicating the section of the ship that is

under threat. The indicators will be centered in the bridge of the ship or on the main deck. The extinction of the fire does not have to be left to the sprayers, they only provide a fust line response, so that once the fire is detected it provides time for other methods to be used. It must be remembered that the operating time of the sprayers is not limitless, and will depend on the amount of fresh water available in the tank. On average it can be said that the sprayers have serviceability for about 20 minutes, but not with all the sections at the same time.

Fixed systems with foam fire extinguishing equipment:

These are mainly used in engine rooms and in ships tanks. And, are generally for class B and also class A fires with foam of low expansion qualities.

The difference between discharge and low expansion foam is the proportion of water used in respect to the foamy solution. The water content in low expansion foam is much greater than in those of high expansion.

The foam can be generated in a chemical form, that is to say, mixing a composition or in mechanical form, that is to say, mixing the first foam concentrated with water to produce a foamy solution and then mixing the air with this solution.

In an engine room a fixed system of fire extinguishing with foam of low expansion is set, it will be able to discharge, through orifices, in no more than 5 minutes, the amount of foam sufficient to cover a layer of 150 mm thick foam to the largest surface are where there are risks of liquid fuel spillage. The expansion ratio of foam will not exceed 12 times to one in volume.

The fixed systems with foam of high expansion will have to be able to unload quickly by discharging through the orifices an amount of foam that is sufficient to fill the greatest of the protected areas at the rate of, at least, a meter of thickness per minute. The amount of foamy liquid will be sufficient to produce a volume of foam that is 5 times greater than the volume of the greatest of the protected areas. The expansion ratio of the foam will not exceed 1.000 times to one in volume.

In the ships tank, the facilities and the amounts of foam to produce are regulated by means of special standards.

Operation of the foam system:

The system must start up manually when a fire in the protected area is discovered. Initially the water pumps foam and the foamy concentrate is activated. Later the corresponding valves are opened to allow that the water and the concentrated foam to flow and mix. If the central system of the foam production provides foamy solution to more than one pipe system, it is necessary to open the valve corresponding to the system that is going to be used. It is important that the crew members that report the fire give the exact location of the fire, so that the appropriate valves can be opened without delay.

When the corresponding valves have been opened and the pumps activated, concentration of foam and water flows towards the mixer where they are mixed in the proportions previously set. Next the foamy solution flows through the pipe until it is discharged to the fire. In a fixed system, the foam is discharged through nozzle s that is located in the area that is being protected.

When the solution flows to each one of the nozzles it is similar to a vacuum cleaner and is mixed with air form the foam bubbles. In most of the fixed systems, the nozzles are directed against bulkheads or a metallic plate so that the foam flows smoothly on the surface of the liquid that is burning. All the nozzles unload the foam at the same time to cover as rapidly as possible the area with a mattress or carpet of foam.

The system will continue operating and producing foam until the foam concentrate is finished in the tank. When this happens, the water will continue flowing through the system. If allowed to continue discharging water after 2 or 3 minutes it will begin to dissolve the foam layer and to undo the protection. With this it will cease to be an effective suppression and so therefore it is very important to close the system when foam is no longer produced.

Fixed systems of fire extinguishing by gas:

The C02 systems are used to protect the hold spaces, the pumping quarters, the generator rooms, the storerooms, as well as the engine room.

Like most extinguishing agent, C02 is very adaptable. It does not damage shipments or the delicate equipment or machinery. It does not leave an undesirable mess that has later to be cleaned. It does not affect the electricity and it can be used with connected electrical equipment, although it is not recommended. When used, it discharges as a pressured liquid and expands until forming a dense gas cloud in the atmospheric pressure. It will be accumulated in the lowest levels of the area that it is being used until it is mixed and it diluted with the atmospheric air.

Nevertheless, the C02 has certain disadvantages. The amount that can be taken on board is limited because it is stored in pressurized cylinders. The C02 has little cooling effect in the materials that have been heated by the fire, since the C02 extinguishes by suppression. Thus, the materials that generate their own oxygen, for example, the celluloid, cannot be extinguished with C02.

The C02 is dangerous for human beings. The minimum concentration that is enough to extinguish a fire, does not get to reduce the oxygen content of the air to a dangerous level, but nevertheless, when it is breathed, the C02 elevates the acid level of the blood. This prevents that the hemoglobin of the blood to absorb oxygen to the lungs which can cause a respiratory problem.

It’s extremely dangerous to be in a department where C02 has been discharged without wearing appropriate artificial respiration apparatus. This is applied even to very short periods of time. For example, a crew member can feel he can hold his breath while he enters to a department flooded with C02 quickly so as to rescue a companion or someone unconscious on the ground but in doing so can become a new victim instead of rescuer.

C02 is very effective against fires of incendiary fuels it also controls class "A" fires but only when they take place in closed spaces.

Types of fixed facilities of C02 on board:

Normally the C02 is stored on board in certain predetermined places such as the engine room and the holds. In general they are systems of total flood and are activated on1y as a last resort after all the other extinguishing methods have been tried and have not been sufficient to control the fire.

This system of total flood in engine rooms for instance is designed to discharge 85% of its total capacity of C02 in two minutes with which it obtains the fast saturation of the atmosphere with C02 and a quick extinction is obtained. The fast discharging in spaces such as the engine room is necessary where incendiary fuels can ignite. Also smaller versions of total flood systems of C02 are used more in reduced spaces.

The systems for the flooding of the hold spaces do not activate immediately after the fire is discovered. The hold space is generally a warehouse of the ship.

The first step is to c10se it as hermetically as possible. After this the C02 is discharged at a predetermined speed so that it reduces the content of oxygen to a level that does not allow the combustion. The systems of C02 for the holds are used in Ro-Ro ships, as well as in ships with containers etc.

All the systems of C02 consist basically of conducting pipes, diffusers of special discharging configuration, valves and cylinders of C02. The cylinders are arranged so that its content unloads in the system through a general collector. The C02 is used to activate the alarm system and the pressure switches that c10se the ventilation systems. The systems of total flood C02 and the systems for the holds can be activated manually.

Operation of a system of C02 of total flood:

A system of total flood activates manually by pulling two cables. The small hands of the cables that have to be pulled are lodged in boxes with a glass door. The cables are connected by means of pulleys to the valves of the pilot cylinders of C02. In order to unload the C02 it is necessary to break the glass with a small

hammer that must be placed next to the cabinet. The cables must be pulled in a suitable manner. Next to the boxes are the instructions of activation that must be followed carefully.

One of the cables is connected to the top of the pilot cylinder; the other is connected to the control valve on the pilot cylinder. When both cables have been pulled, the C02 discharges from both pilot cylinders and open the pilot valve.

By means of a retaining valve the discharging of the C02 is slowed down to the area that has to be protected. During this delay, the C02 goes through the pilot valve towards the device for retardation in the pipe, activating the pressure switches. It takes about 20 seconds for the C02 to pass through the retardation device. During this time, the ventilation systems are closed and the alarms are activated. Once the 20 seconds has passed, the C02 opens a pressure control (Regulator) mounted near the retention valve. This valve is opened and allows the C02 to discharge into the protected spaces.

Alarm of discharging of the C02:

In each one of the spaces that are protected by a system of total flood of C02 an acoustic alarm must be set that is audible for all the people who are on board to hear when the ship is steaming. The alarm must be configured to sound automatically for 20 seconds immediately prior to the discharging of the C02. This alarm does not have to depend on any other power plant that may be different from the one for the other C02 system. The alarm must be in a very visible site and marked with the appropriate warning signs.

Procedure for the extinction of fires by means of C02:

In the case of a fire in the engine room, once the decision is made to discharge the C02; to completely flood all the engine room with C02, it is necessary to follow strict procedures, for example; the alarm is a warning that means that the C02 has been activated. Once the sound of the alarm is heard

there about 20 seconds to leave the engine room. It is important not to be delayed and to leave immediately. If the place is not evacuated immediately there is risk of facilities.

The specific steps to be taken are as follows:

- ✓ Warning all the personnel to evacuate the area.
- ✓ Close all the doors, hatchways and other openings.
- ✓ Go to all the outlet boxes of the C02 system corresponding to the place that need to be protected.
- ✓ Break the glass of the box and pull on the "control valve" handle
- ✓ Immediately after break the glass of the box and pull on the handle marked "control cylinder"

The C02 system can also be activated from a central position in the same area where the cylinders are kept. The procedure is slightly different. It consists of retiring the safety pins of the valves of the cylinders and operating the handles of the control heads that they are mounted on. This applies to both pilot cylinders and the pilot valves. The delay in discharging of the C02 can be eliminated if the safety pin is refired and is activated in the operation handle of the control cylinder that is mounted in the retention valve.

13. Use of breathing apparatus for fighting fires.

Many firefighting situations may require the use of some form of breathing apparatus. The use of such equipment will ensure a supply of oxygen to the wearer so that he can perform his particular tasks in safety. Two basic types are in use—the smoke helmet and the self-contained unit using air cylinders.

The smoke helmet arrangement uses a helmet which covers the head and is connected to an air hose. A hand operated pump or bellows supplies the air. A system of signals between user and supplier must be arranged to ensure safe,

correct operation.

The self-contained unit consists of one or two cylinders of compressed air kept in a harness which is carried on the back (Figure). The high pressure air is fed through a reducing valve and then to a demand valve. The demand valve is fitted into a face mask and supplies air to meet the breathing requirements of the wearer.

A non-return valve permits breathing out to atmosphere. A warning whisde sounds when the air pressure falls to a low value. A standard cylinder will allow for about 20 to 30 minutes' operation.

Types of equipment

Air may be used in several different ways to provide life support and consequently breathing, rescue and resuscitation equipment is available in many different forms depending on the particular requirement, and is produced by a number of manufacturers. The main basic types may be listed as follows: -

- Self-contained compressed air breathing apparatus, both demand and positive pressure types.
- Airline breathing equipment served by cylinder pack.
- Emergency escape breathing devices. (EEBD)
- Emergency life support apparatus. (ELSA)
- Resuscitation equipment.

During the use of all compressed air breathing equipment, other than escape sets, E.L.S.A. sets and resuscitation apparatus, a record of the operational usage must be kept on the bridge to provide warning for those outside a space of when an air supply is about to be exhausted. The method of establishing the allowable time in a

space wearing an S.C.B.A. set is described below.

During preparation of the above equipment strict adherence to the manufacturers instructions must be complied with. A description of the types of equipment onboard is to be included within the ship-specific Fire Training Manual if carried

Working duration of S.C.B.A.

The working duration of a self-contained breathing apparatus will vary considerably from one wearer to another and will also depend on the amount of effort being expended. As a rough guide, it can be assumed that a trained wearer in fit condition and working reasonably hard will consume about 40 litres of free air per minute; and inexperienced person can easily double this rate of consumption.

Compressed air cylinders are of various sizes, usually of either 9 or 6 litre water capacity. The fully charged pressure of cylinders also varies. Some types are charged to as high as 300 bar (4500 p.s.i.). The maximum charging pressure is always stamped on either the neck or the shoulder of a cylinder. To obtain the approximate quantity of free air in a cylinder, simply multiply the water capacity in litres by the pressure in either bars, atmospheres or Kg/cm2. For example, a 6 litre cylinder charged to 200 bars: 6 x 200 = 1200 litres (approximately) On the basis of a consumption of 40 litres/minute the rated Total Duration of such a cylinder would be: 1200 = 30 minutes. 40 However, the Working Duration always allows for a safety reserve of 10 minutes and in this case it will therefore be 20 minutes.

A log is to be maintained by the Emergency Party which will record time of entry into a space, time due out, and bottle air pressure for each SCBA wearer.

Face masks

Most modern facemasks are made of neoprene or similar durable and chemical resistant materials. There are, however, some that are still made of rubber based materials. Regardless of type, facemasks should always be washed in mild soapy water (not detergent) after use and then rinsed in clean fresh water, wiped with a clean cloth and allowed to dry gently. Rubber based masks should periodically be treated with paraffin wax to prevent perishing. Visors should be protected against scratching. Minor scratches and marks are sometimes unavoidable but most can be easily removed by polishing with brass polish.

Exhale valves, which are allowed to become dirty will not seal properly and toxic atmosphere may then enter the mask. Rubber valves found in the Demand type sets will become stretched or perished after a while and it is important to renew them in accordance with the manufacturer's instructions.

Many masks are fitted with an inner or ori-nasal mask, the purpose of which is two-fold. All exhaled air is confined to the space in this inner mask before it is exhausted to atmosphere. This not only reduces the possibility of a build-up of CO2 within the mask as a whole but it effectively minimises misting of the visor.

Fireman's outfits

For tackling serious fires, fireman’s outfits are supplied which consist of special heat resistant suit, gloves, boots and helmet, as well as additional equipment such as safety lamps, fire axes and breathing apparatus. It is essential that the fire suit is cared for and stowed neatly without creasing, ready for immediate use.

All firemen’s outfits are to be checked weekly to ensure all equipment is present. Safety lamps are to be tested monthly to ensure correct operation. Rechargeable batteries are to be discharged and then recharged to prolong their life expectancy.

Refilling air bottles

Air bottles can be refilled on board where an air compressor especially designed for this purpose is fitted. There is a strict criteria laid down for systems supplying compressed air for breathing purposes. The compressors must provide air which is free from any contaminants that could cause harm to health, cause discomfort or be detrimental to the safe operation of the air bottles. The air must also be free from bad smells or taste. Air contained in BA bottles must be changed at least every two years. Records are to be maintained accordingly.

Annual testing is to be carried out by a competent shore maintenance company to check for the quality of the air from the compressor in order to ensure it is free from oil particles and other contaminants. After a successful test, a certificate is to be issued and retained onboard.

If a BA bottle compressor is fitted it is to be connected to the ship's emergency power supply. A log of running hours is to be maintained along with a record of maintenance including dates of filter changes. Where there is no BA bottle compressor on board, bottles are to be sent ashore for recharging. Air bottles are to be pressure tested ashore every five year or as required by Flag, whichever is the shorter period.

Emergency escape breathing devices (EEBD)

An EEBD is a supplied air or oxygen device to be only used for escape from a compartment that has a hazardous atmosphere. EEBDs shall not be used for fighting fires, entering oxygen deficient spaces, or worn by fire fighters.

An EEBD shall have service duration of at least 10 minutes. The number of EEBDs onboard is dependent upon Flag State regulations. The location of this equipment is to be clearly shown on the Fire Control Plan. Consideration should be given for placing such devices along the escape routes within the machinery spaces or at the foot of each escape ladder within the space. In addition, control spaces and work shops located within the machinery spaces should also be considered for the possible location of such devices.

14. Use of breathing apparatus for effecting rescues.

There are 3 main types of Breathing Apparatus – Escape, Self-Contained and Airline.

Escape Breathing Apparatus

Escape Breathing Apparatus is used for self-rescue from an environment that has become hazardous after entry into it. The most common example of this in-use is in a confined space where there is no immediate danger from gas or oxygen deficiency but the risk of that danger remains, and so an Escape BA set is carried enabling the user to don the set and rescue themselves from a hazardous environment. An Escape Set consists of a small compressed air cylinder, either

2.0L or 3.0L in size, that feeds air into a face piece. Escape Sets are usually supplied with either a positive pressure close-fitting face mask or with a loose fitting hood. Regular users of full face masks will usually prefer the comfort and familiarity of a close-fitting face mask, whilst irregular users will find the loose fitting hood easier to don in an emergency situation. It is worth noting as well that a loose fitting hood accommodates users with facial hair and glasses.

Self- Contained Breathing Apparatus

Self-Contained Breathing Apparatus (SCBA) or Compressed Air Breathing Apparatus (CABA) is used for entry into a known hazardous environment. One user we will all recognise is the Fire Services, who use SCBA to enter areas where smoke and noxious gases are present, but SCBA is used in many entries where there is a toxic gas, asphyxiate or oxygen deficient environment. A SCBA set consists of 3 main components – a cylinder of compressed air, a back-plate that holds the cylinder and reduces the air from high pressure (200-300bar) to medium pressure (5-11 bar) and this in turn supplies a face mask. Self-Contained BA gives autonomy to the user, meaning that they can move around freely as opposed to being attached to an airline. However, the disadvantages are that the cylinder has a relatively short supply time, for example a 9.0L 200 bar cylinder giving a usage time of 35 minutes, and also the cylinder means an increased size and therefore can hinder ease of movement through tight spaces. There are many different sizes

of cylinders which can improve duration or manoeuvrability, but these limitations will still remain to some extent.

Airline Breathing Apparatus 

Airline Breathing Apparatus is where the air supply is removed from the user and they are fed compressed air via an airline. The compressed air source should deliver them air that has been air quality tested to EN12021, and may be supplied from a cylinder bank or breathing air compressor, which may be either fixed or mobile. The airline supplies the user's face mask through an airline harness. An airline system often incorporates an escape cylinder which the user wears to ensure that in the event of the main air supply failing they have a short duration air supply to allow to self-rescue themselves safely. Airline systems are used where the work is relatively localised and likely to be for longer durations. The main disadvantage of being attached to an airline is that it restricts easy movement, and poses a risk of entanglement. However, by being attached to an airline the user can work for as long as is comfortable and safe for them in the environment they are in without the requirement to refill or change a cylinder. A very good example of where an airline system is relevant is tank cleaning. A large tank may take several days or even weeks to thoroughly clean, so an airline breathing apparatus may be

required in this one area for long durations. Particular attention should be paid to selecting a suitable air supply source for the work site.

Accidents are usually the result of carelessness, mistakes, lack of thought or care, and often result in injury. Consideration will now be given to avoiding accidents, largely by the adoption of safe working practices. Working clothes should be chosen with the job and its hazards in mind. They should fit fairly closely with no loose flaps, straps or ragged pockets. Clothing should cover as much of the body as possible and a stout pair of shoes should be worn. Neck chains, finger rings and wristwatches should not be worn, particularly in the vicinity of rotating machinery. Where particular hazards are present appropriate protection, such as goggles or ear muffs, should be worn.

When overhauling machinery or equipment it must be effectively isolated from all sources of power. This may involve unplugging from an electrical circuit, the removal of fuses or the securing open of circuit breakers. Suction and discharge valves of pumps should be securely closed and the pump casing relieved of pressure. Special care should be taken with steam-operated or steam-using equipment to ensure no pressure build-up can occur.

When lifting equipment during overhaul, screw-in eye bolts should be used where possible. These should be fully entered up to the collar and the threads on the eyebolt and in the equipment should be in good condition. Any lifting wires should be in good condition without broken strands or sharp edges.

Before any work is done on the main engine, the turning gear should be engaged and a warning posted at the control position. Lubricating oil in the working area should be cleaned up and where necessary suitable staging erected. The turning gear should be made inoperative if not required during the overhaul. Where it is used, care must be taken to ensure ail personnel are clear before it is used.

Where overhead work is necessary suitable staging should be provided and adequately lashed down. Staging planks should be examined before use and where suspect discarded. Where ladders are used for access they must be secured at either end. Personnel working on staging should take care with tools and store them in a container.

Boiler blowbacks can cause serious injury and yet with care can usually be avoided. The furnace floor should be free of oil and burners regularly checked to ensure that they do not drip, particularly when not in use. The manufacturer's instructions should be followed with regard to lighting up procedures. Generally, this will involve blowing through the furnace (purging) with air prior to lighting up. The fuel oil must be at the correct temperature and lit with a torch. If ignition does not immediately occur the oil should be turned off and purging repeated before a second attempt is made. The burner should be withdrawn and examined before it is lit.

Entry into an enclosed space should only take place under certain specified conditions. An enclosed space, such as a duct keel, a double bottom tank, a cofferdam, boiler, etc. cannot be assumed to contain oxygen. Anyone requiring to enter such a space should only do so with the permission of a responsible officer. The space should be well ventilated before entry takes place and breathing apparatus taken along; it should be used if any discomfort or drowsiness is felt. Another person should remain at the entrance to summon assistance if necessary, and there should be a means of communication arranged between the person within the space and the attendant.

Lifelines and harness should be available at the entrance to the space. The attendant should first raise the alarm where the occupant appears in danger but should not enter the space unless equipped with breathing apparatus.

Training in the use of safety equipment and the conduct of rescues is essential for all personnel involved.

Emergency procedures for rescue from enclosed spaces

Initial alarm: A responsible member of the crew outside an enclosed space who notices something wrong within, or any other person who sees or suspects a casualty within an enclosed space should first raise an Alarm. On no account should the person(s) attempt to enter it before additional help has arrived, and no one should enter any space or attempt to rescue, without wearing a breathing apparatus set.

The only exception to the rescuer not wearing a breathing apparatus set is when it is positively known that the cause of the accident was not a deficiency in the space atmosphere.

Mustering of rescue resources

On hearing an alarm, the Master or responsible officer should muster a Rescue Team comprising at least 2 persons and a third person in charge who should remain outside the space to exercise control. Unless not already ready at space entrance before the enclosed space entry was permitted, the following minimum items should be assembled at site :

• 2 x Self Contained Breathing Apparatus

• EEBD

• Resuscitator

• Lifelines (to be used unless impracticable)

• Rescue Harness / Neil Robertson stretcher, with rope

Rescue

The rescuers entering the enclosed space must wear a SCBA and carry an EEBD and Rescue Harness for use of casualty.
They should be in continuous communication with the rescue supervisor who in turn should apprise the Master of the events.

Personnel should be allocated to relieve or back-up the rescue team. Support team should arrange back up equipment outside space like spare SCBA bottles, ropes, first aid equipment, and possibly hoisting equipment to aid in lifting the casualty.

A stretcher if available is necessary to evacuate any casualty with suspected neck or spinal injuries, after fastening him .
In other cases, a rescue harness may be used. If necessary, the EEBD is to be used to supply the casualty with fresh air,

In case the casualty requires artificial respiration, then the resuscitator must be used.

Note : “Resuscitation apparatus” provided to all Tankers, it should be always kept for immediately use, should be stowed where it is easily accessible and not kept

locked up and also crew must be aware of its location and are trained in its proper use.

The casualty should be moved to the nearest safe adjacent area outside the enclosed space unless his injuries and the likely time of evacuation makes some treatment essential before he is moved.

Medical advice is to be sought from shore as required.