SEAFARERS TRAINING CENTER INC

ADVANCED TRAINING IN FIRE FIGHTING

In compliance with the 1978 International Agreement on Standards of Training, Certification and Watch keeping for Seafarers Code (STCW as amended)

SCOPE

This course aims to provide the training in advanced fire fighting in accordance with Section A-VI/3 of the STCW Code. The emphasis of the training is in organization, tactics and commands.

OBJECTIVE

This course covers the requirements of the 1995 STCW Convention Chapter VI, Section A-VI/3 and the Table A-VI/3. On meeting the minimum standard of competence in advanced fire fighting, a trainee will be competent to take command, organize and train fire parties and control fire-fighting operations. The seafarer will have acquired a knowledge of fire prevention and an ability to inspect and service fire detection and extinguishing systems and equipment. He or She will also be able to investigate and report on incidents involving fire.

ENTRY STANDARDS

The course is open to seafarers who have complete basic training in fire prevention. All trainees must be certified by a doctor to be in good health.

COURSE CERTIFICATE

On successful completion of the course and demonstration of competence, a document may be issued certifying that the holder has met the standard of competence specified in Table A-VI/3 of the STCW Code 1995.

COURSE INTAKE LIMITATIONS

The maximum number of trainees attending each session will depend on the availability of instructors, equipment and facilities available for conducting the training. Any practical training should be undertaken in small groups of not more than six trainees per instructor.

STAFF REQUIREMENTS

Instructors shall have appropriate training in instructional techniques and training methods (STCW Code A-I/6, pa.7). In addition, all training and instruction should be given by qualifies personnel; the senior instructor, having considerable experience in fire safety and fire-fighting techniques, should have a good knowledge of ships, including stability considerations. All

assistant instructors should have practical knowledge of fire fighting and should be familiar with ships. During any practical training one instructor must be in charge of each group. Staff may be recruited from the local brigade.

TEACHING FACILITIES AND EQUIPMENT

Ordinary classroom facilities and an overhead projector are sufficient for the theoretical part of the course. When making use of audiovisual material such as videos or slides, make sure the appropriate equipment is available.

For the practical part of the course it would be advantageous if the training facilities of a local or port fire brigade could be used.

TEACHING AIDS

- Instructor Manual.
- Audio-visual aids-video cassette player, TV, Slide Projector, OHP etc.

BIBLIOGRAPHY

- Fighting_Fire_Containerships.pdf ABS
- Guidance Notes on Fire-Fighting Systems .pdf ABS
- ANNEX P: MARINE FIREFIGHTING, VESSEL SALVAGE &
- LIGHTERING

TIMETABLE
COURSE OUTLINE
Competence 1: Control fire-fighting operations aboard ships

Couse Outline	Approximate tine (hours)
Knowledge , understanding and proficiency	**Lectures, demonstration and practical work**
1.1 Introduction, safety and principles.	0.5
1.2 Areas of fire hazards.	0.75
1.3 Fire Precautions.	0.75
1.4 Dry Distillation.	0.5
1.5 Chemical reactions.	0.5
1.6 Boiler uptake fires and exhaust fires in prime movers and auxiliary exhausts.	0.5
1.7 Fires in water tube boilers.	0.5
1.8 Tactics and procedure of fire control while ship is at sea.	0.5
1.9 Tactics and procedure of fire control while ship is in port.	0.5
1.10 Tactics and procedure of fire control while ship is carrying dangerous goods.	0.5
1.11 Tactics and procedure of fire control for oil, chemical and gas tankers.	0.5
1.12 Use of water for fire extinguishing, the effect on stability, precautions and corrective procedures.	0.25

1.13 Communication and co-ordination during fire-fighting operations.	0.25
1.14 Ventilation control including smoke extractor.	0.25
1.15 Control of fuel and electrical systems.	0.25
1.16 Fire precautions and hazards associated with the storage and handling of materials (paints, etc).	
1.17 Management and control of injured persons	1.5
1.18 Procedures for co-ordination with shore-based fire fighters.	0.25
Sub -total	9
Competence 2: Organize and train fire parties	
2.1 Preparation of contingency plans.	0.25
2.2 Composition and allocation of personnel to fire parties.	0.75
2.3 Training of seafarers in fire-fighting	3.5
2.4 Fire Control Plans	0.25
2.5 Organization of fire and abandon ship drills	0.75
2.6 Strategies and tactics for control of fires in various parts of the ship	0.5
Sub-total	6.0
Competence 3: Inspect and service fire-detection and fire-extinguishing systems and equipment	
3.1 Fire alarms	0.25
3.2 Fire detection equipment	1.0
3.3 Fixed fire-extinguishing equipment	1.75
3.4 Fire main, hydrants, hoses, nozzles and pumps	1.0
3.5 Portable and mobile fire extinguishing equipment including appliances	1.0
3.6 Firefighter's outfits and other personal protection equipment	1.5
3.7 Rescue and life support equipment	1.25
3.8 Salvage equipment	0.5
3.9 Communication equipment	0.75

3.10Requirements for statutory and classification surveys.	1.0
Sub -total	10.0
Competence 4: Investigate and compile reports on incidents involving fire	
4.1 Fire Investigation and reporting	2.0
4.2 Trainee's experience of fire on ships	1.0
4.3 Documented reports of fires on ships and lessons learned	1.0
Sub total	4.0
ASSESSMENT	1.0
Total	30.0

COURSE TIMETABLE

	Day 1	Day 2	Day 3	Day 4
1st Period	Competence 1: Control fire-fighting operations aboard ships	Competence 2: Organize and train fire parties continued)	Competence 3: Inspect and service fire-detection and fire-extinguishing systems and equipment	Competence 4: Investigate and compile reports on incidents involving fire
2nd Period	Competence 1: Control fire-fighting operations aboard ships (continued)	Competence 2: Organize and train fire parties continued)	Competence 3: Inspect and service fire-detection and fire-extinguishing systems and equipment (continued)	Competence 4: Investigate and compile reports on incidents involving fire (continued)
Break Lunch				
3rd Period	Competence 1: Control fire-fighting operations aboard ships (continued)	Competence 2: Organize and train fire parties	Competence 3: Inspect and service fire-detection and fire-extinguishing systems and equipment	Competence 4: Investigate and compile reports on incidents involving fire (continued)
4th Period	Competence 1: Control fire-fighting operations aboard ships (continued)	Competence 2: Organize and train fire parties continued)	Competence 3: Inspect and service fire-detection and fire-extinguishing systems and equipment (continued)	Competence 4: Investigate and compile reports on incidents involving fire (continued)
				ASSESSMENT

1. Control fire-fighting operations aboard ships

1.1 Introduction, safety and principles.

Marine firefighting is a general term used to describe activities to extinguish any types of fire, however caused, in a marine environment. For many years this meant dealing with fires on seagoing vessels, or more specifically, shipping.

At one time, marine fire risks were primarily associated with shipping and the vessels or their cargoes. The principal causes of fires at sea on vessels are accidents, collisions, mechanical failure in engines and cargoes catching fire. On passenger vessels, fires are the result of collisions, on-board accidents and mechanical failure. In the 21st century, the seas and oceans are increasingly becoming sites for static structures. Many of these are associated with oil, gas and other mineral exploration and harvesting in which mechanical processes, working in volatile environments, are required to bring gaseous or liquid hydrocarbons from beneath the sea bed to production platforms and then onto ships or into pipelines to bring them ashore for processing. Other structures, both fixed and floating, are also being erected at, or towed to, locations in many coastal waters around the world. These include offshore wind farms, tidal and wave power renewable energy installations, scientific research and monitoring stations as well as military and defense installations.

Clearly the range of fire hazards associated with these different activities varies widely and will depend considerably on the risks of accidents, combustibility of the materials used in structures, the types of cargoes carried in ships and the flammability of minerals being extracted on petrochemical production platforms in these marine environments. In some situations, firefighters will be able to work

onboard, depending on the severity of the fire, but, following a blow out or explosion aboard an oil rig or gas production platform, fighting the ensuing fire may only be possible from firefighting vessels.

Also, the characteristics of the fires facing firefighters will reflect the volatility and flammability of the materials involved in the conflagration. Some materials burn much hotter than others. Some will throw off burning shards or molten materials, some can be unpredictable either due to the composition of the flammable materials involved (in particular hydrocarbons and chemicals) or prevailing weather conditions. Wind speed and direction can be particularly variable out at sea and can cause rapid changes in the levels of hazard experienced by firefighters.

1.2 Areas of fire hazards.

Machinery Spaces

The causes of engine room fires can usually be traced back to a lack of maintenance or bad watchkeeping practices.

They are usually caused by:

- Combustible liquids leaking through faulty or damaged connections,
- Oil-soaked insulation,
- Hot surfaces, e.g. exhaust pipes, engine parts overheating in close proximity to oil lines,
- Defects in lagging,
- Hot work, e.g. welding, cutting by oxy-acetylene torch,
- Autoignition, e.g. oil dripping on hot surface.

To confine a fire to the zone of origin, for a specified time, thereby preventing fire spread and leaving more time for safe evacuation of the building occupants. Specifically engineered containment systems are used as enclosures in instances where specific identifiable hazards within a building need to be independently isolated from the remainder of the building. Fire-resistive enclosures used for containment are subjected to fire exposure conditions specified in various related test Standards.

Some methods of Containment in Machinery Spaces are:

- Watertight Doors,
- Fire Doors,
- Dampers,
- Water sprays and screens, and remote control of these where applicable.

Fire detectors sense one or more of the products or phenomena resulting from fire, such as smoke, heat, infrared and/or ultraviolet light radiation, or gas.

Some methods of detection in Machinery Spaces are:

- Smoke detectors,
- High-temperature probes,
- Rate-of-rise of temperature probes,
- Patrols.

Accommodation

A ship accommodation is an area where the crew member's cabin is located along with galley, recreational room, meeting room etc. The best way to avoid incidents of fire on ship is to take preventive measures than to suffer later.

Some causes can be:

- Combustible materials,
- Matches and cigarette smoking, including careless disposal of burning cigarettes or ash,
- Textiles adjacent to hot objects such as radiators and laps,
- Defective and overload electrical systems,
- In a laundry, incorrect installation of a tumble drier or failure to keep in clean.

Methods of Containment:

- Fire doors and dampers,
- Sprinkler system,
- Fire-retardant materials in construction,
- Fire-retardant deck coverings,
- Fire-retardant furnishings.

Methods of Detection:

- Smoke detectors,
- Temperature probes,
- Sprinkler system,
- Patrols.

1.3 Fire Precautions.

Structural Fire Protection

A non-combustion material is defined as one that neither burns nor gives off flammable vapours in sufficient quantities for self-ignition when heated to approx 750C.

Any material other than a non-combustible material is a combustible material.

Structural fire protection is taken care of in the design and construction stage of a vessel and include following measures.

- Division of vessel into main vertical zones by thermal and structural boundaries.
- Separation of accommodation spaces from the remainder of ship by thermal and structural boundaries.
- Restrict use of combustible material.
- Containment and extinction of fire in the space of origin.
- Protection of access for fighting fire as well as means of escape.
- Ready availability of fire extinguishing appliances.
- Minimization of possibility of ignition of flammable vapour.

Standard Fire Test

A standard fire test is one in, which specimens of relevant bulkheads or decks are exposed in a test furnace to temperatures corresponding approximately to the standard time temperature curve. The specimen must have as a minimum, height or length 2.44m, exposed surface area of 4.65 m2 and a joint over a period of 60 minutes, this specimen is then exposed to temperatures ranging from 556o c to 925o c.

A Class division

a. Constructed of steel or equivalent material and suitably stiffened.
b. Insulated with approved non-combustible material.
c. Must prevent the passage of smoke and flame to the end of one-hour standard fire test.

d. If subjected to a standard fire test, average temp. of unexpected side will not rise more than 140 c above the original temperature and temperature at any one point, including any joint will not rise more than 180o c above the original temperature within the time listed below.

Class A – 60: 60 minutes, Class A – 30: 30 minutes.
Class A – 15: 15 minutes, Class A – 0: 0 minutes.

B Class division

a. Constructed of approved non-combustion material
b. Must prevent the passage of smoke fire test, average temperature of unexposed side will not rise more than 140o c above the original temperature nor will temperature at any one point including any joint will rise more than 225o c above original temperature within the time listed below:
   Class B – 15: 15 minutes, Class B – 0: 0 minutes.

C Class Division

Constructed of approved non-combustion materials and need not meet any requirements regarding passage of flame/smoke or limitations relative to temperature rise. On a tank vessel, cargo pump room, cargo tanks, slop tanks and cofferdams must be positioned forward of machinery spaces. However, bunker tanks need not be forward of machinery spaces.

1.4 Dry Distillation.

Is a combustion process in which a flammable material burns with insufficient oxygen to achieve complete combustion of the material. It can be a very dangerous stage of a fire and should be dealt with accordingly, including a warming of the existence of a high concentration of carbon monoxide.

The main point which must be stress when dealing with the chemical reactions is that ordinary fire-fighting media such a water and sand may have an adverse reaction with some types of chemical fires. The production of toxic gases from some plastics must also be given prominence.

The “iron in steam” fire are sometimes known as “steel fires” and mostly take place on the uptake of the ship. The important fact about them is that they should not be fought as normal fires, since the consequence of so doing may be disastrous. Patient is required with such fires as, generally, they have to be allowed to burn themselves out; the fire-fighters have to concentrate on preventing any spread of the fire.

If direct fire fighting has to be done, the recommend method is to direct as any jet of water as practicable as the seat of the fire. Water sprays, foam or something methods must not be used. The hydrogen fire which may burn simultaneously with the iron-in-steam fire should be controlled but not extinguished until the iron-in-steam fire is out; this is to avoid the possibility of an explosion.

1.5 Chemical reactions.

A chemical reaction is a process that leads to the transformation of one set of chemical substances to another. Classically, chemical reactions encompass changes that only involve the positions of electrons in the forming and breaking of chemical bonds between atoms, with no change to the nuclei (no change to the elements present), and can often be described by a chemical equation. Nuclear chemistry is a sub-discipline of chemistry that involves the chemical reactions of unstable and radioactive elements where both electronic and nuclear changes can occur.

The substance (or substances) initially involved in a chemical reaction are called reactants or reagents. Chemical reactions are usually characterized by a chemical change, and they yield one or more products, which usually have properties different from the reactants. Reactions often consist of a sequence of individual sub-steps, the so-called elementary reactions, and the information on the precise course of action is part of the reaction mechanism. Chemical reactions are described with chemical equations, which symbolically present the starting materials, end products, and sometimes intermediate products and reaction conditions.

Chemical reactions happen at a characteristic reaction rate at a given temperature and chemical concentration. Typically, reaction rates increase with increasing temperature because there is more thermal energy available to reach the activation energy necessary for breaking bonds between atoms.

Reactions may proceed in the forward or reverse direction until they go to completion or reach equilibrium. Reactions that proceed in the forward direction to

approach equilibrium are often described as spontaneous, requiring no input of free energy to go forward. Non-spontaneous reactions require input of free energy to go forward (examples include charging a battery by applying an external electrical power source, or photosynthesis driven by absorption of electromagnetic radiation in the form of sunlight).

Different chemical reactions are used in combinations during chemical synthesis in order to obtain a desired product. In biochemistry, a consecutive series of chemical reactions (where the product of one reaction is the reactant of the next reaction) form metabolic pathways. These reactions are often catalyzed by protein enzymes. Enzymes increase the rates of biochemical reactions, so that metabolic syntheses and decompositions impossible under ordinary conditions can occur at the temperatures and concentrations present within a cell.

The general concept of a chemical reaction has been extended to reactions between entities smaller than atoms, including nuclear reactions, radioactive decays, and reactions between elementary particles as described by quantum field theory.

1.6 Boiler uptake fires and exhaust fires in prime movers and auxiliary exhausts.

Uptake fire in Marine Diesel Engine and boiler

Engine exhaust gas contains particulates which of partially burn fuel and/or lubricating oil and ash. This particulates form deposits on boiler tubes. Especially during prolonged low load operation, which reduces exhaust gas velocity, it may lead higher soot deposition. It may be due to burning poor quality fuel, poor combustion due to effective injection equipment, or inefficient fuel treatment.

These deposits on the tubes may get heated and rise above self-ignition temperature. Soot deposits may be ignited by glowing carbon particulates in the exhaust gases. The ignition temperature of the soot is usually less than 400 C, however if the deposit stick, it could fall below 200 C.

Soot fires can occur after the engine has shut down, therefore it is important to maintain water circulation after shut down.

The fire will be indicate by dark smoke coming out of funnel large rise in exhaust gas temperature after the boiler.

Action:

- If fire does occur the engine should be stopped immediately and the turbocharger air intake covered to starve the fire of air.
- Ensure full water circulation is maintained.
- A small fire may burn itself out as the will be conducted away by the circulating water.
- If water washing system is fitted, it can be used to extinguish the fire.

Prevention:

- Soot Blowers

  Soot blowing should be carried out on regular basis to ensure soot and ash deposits do not built up on tubes. It should be carried out more frequently when the engine is operating at low loads or when fuel has high ash content. It should be carried out after water washing of main engine turbocharge (water side).

– Water washing of exhaust gas boiler

The combustion of residual fuel results in formation of slag. These slag gradually built up on the boiler tubes. Soot blowing keeps these deposits at low levels, however it does not reach all areas of boiler. These slag are soluble in water and can be removed by hot water washing.

1.7 Fires in water-tube boilers.

A fire-tube boiler is a type of boiler in which hot gases from a fire pass through one or (many) more tubes running through a sealed container of water. The heat of the gases is transferred through the walls of the tubes by thermal conduction, heating the water and ultimately creating steam.

The fire-tube boiler developed as the third of the four major historical types of boilers: low-pressure tank or "haystack" boilers, flued boilers with one or two large flues, fire-tube boilers with many small tubes, and high-pressure water-tube boilers. Their advantage over flued boilers with a single large flue is that the many small tubes offer far greater heating surface area for the same overall boiler volume. The general construction is as a tank of water penetrated by tubes that carry the hot flue gases from the fire. The tank is usually cylindrical for the most part—being the strongest practical shape for a pressurized container—and this cylindrical tank may be either horizontal or vertical.

This type of boiler was used on virtually all steam locomotives in the horizontal "locomotive" form. This has a cylindrical barrel containing the fire tubes, but also has an extension at one end to house the "firebox". This firebox has an open base to provide a large grate area and often extends beyond the cylindrical barrel to form a rectangular or tapered enclosure. The horizontal fire-tube boiler is also

typical of marine applications, using the Scotch boiler. Vertical boilers have also been built of the multiple fire-tube type, although these are comparatively rare; most vertical boilers were either flued, or with cross water-tubes.

Water tubes

Fire-tube boilers sometimes have water-tubes as well, to increase the heating surface. A Cornish boiler may have several water-tubes across the diameter of the flue (this is common in steam launches). A locomotive boiler with a wide firebox may have arch tubes or thermic syphons. As firebox technology developed, it was found that placing a baffle of firebricks (heat-resistant bricks) inside the firebox to direct the flow of hot flue gasses up into the top of the firebox before it flowed into the fire tubes increased efficiency by equalizing the heat between upper and lower fire tubes. To hold these in place, a metal bracket was used, but to prevent these brackets from burning and eroding away they were built as water tubes, with cool water from the bottom of the boiler moving upwards by convection as it heated, and carrying the heat away before the metal reached its failure temperature.

Another technique for increasing the heating surface is to include internal rifling inside the boiler tubes (also known as Serve tubes).

Not all shell boilers raise steam; some are designed specifically for heating pressurized water.

1.8 Tactics and procedure of fire control while ship is at sea.

Fire Emergency Procedures at Sea

- Sound alarm (advice Master and officer on watch)

- Muster alarm list to be followed, and operation order to be established
- Close doors and stop ventilation
- Localize fire and notify personnel concerned with the scat of fire
- Identify cargo, dangerous cargo and substances in the vicinity
- Analyse method or extinguishing
- Analyse development of the fire and limit it by cooling
- If necessary consider evacuation of the vessel and prepare all documents to be saved
- Message to be sent to Company and if required, to other third parties
- Once extinguished, cancellation message to be sent to all parties concerned
- Enter all measures and actions taken in logbook

The best protection against a fire-casualty is the prevention and a vessel should dispose of a well-trained and disciplined crew, disposing of adequate good working firefighting equipment.

It is therefore recommended that during the weekly boat and fire drills, attention should be paid in properly explaining the working of the equipment and the proper use demonstrated.

Also from time to time a simulated fire-drill should be organized such as:

- an engine-room fire fighting
- a cargo hold fire fighting
- an accommodation fire fighting
- a galley fire fighting etc.

When a fire originates in the engine room, a boiler room or a hold, the first step will be to turn off all fans, to close all ventilator flaps, skylights, openings, entrances etc. and to keep the burning compartment(s) sealed in order to make it as airtight as possible.

A very efficient fire fighting agent is C02 but careful attention must be paid to risk of suffocation and should not be used as long as human life is present in the area where the fire is developing.

Usually fires in a general cargo hold are more difficult to extinguish with C02 than fires in an engine room and it may not be possible to completely extinguish a deep seated fire at sea by the only use of C02 (or halons). However, by working on one or two the elements of the fire triangle i.e. by seating of the hold and using C02, which reduces the amount of oxygen, and by cooling off, it may be possible to keep a burning cargo hold under control until the vessel reaches a port.

Please note that C02 should be released gradually and that the instructions for the C02 total flooding should be followed, taking into consideration the volume of the burning compartment. Calculate the approximate free air volume in the compartment and compensate for the air volume contained in the cargo depending on its composition.

About 50 lbs of C02 are required for each 1000 cub feet of air in a compartment (equal to 0.7 kgs of C02 for 1 m3 of air) in order to obtain the extinguishing 40 % gas air mixture. As the gas is heavier than the air, the gas tends to sink down to the lowest parts of the compartment.

It has however to be borne in mind, that a fire in nitrates, chlorates and other substances rich in oxygen cannot be extinguished with C02 but only by water. When water is used extensively the vessel's stability must be closely watched.
It is important to localize as soon as possible the seat of the fire., e.g. by means of measuring the temperature at decks, bulkheads and in air and sounding pipes; if the seat of the fire is close to a bulkhead, steps must be taken to prevent the fire from spreading to the other side.

It should also be reminded that water must not be used for fighting fires involving vessel's electrical and / or electronic equipment.

It usually takes quite some time to totally extinguish a fire by means of C02 (up to 8-10 days). During such period hatches etc. must be kept closed and not opened for inspection until the temperature at the seat of the fire is again normal. Any premature opening for inspection could rekindle the fire.

Fires in accommodations and storerooms present an additional hazard on account of the use of modern materials such as polyvinyl chloride, polyurethane, polystyrene, polypropylene, acrylene, nylon, etc.

Real dangers are:

- its capability to blaze up a fire
- the generating of dense toxic and / or poisonous gases.

The fire fighting agent together with the tactics to be used will certainly depend on the concentration and the types of the materials present, the free surfaces of such materials and the air circulation.

Several areas in the vessel will contain more plastic materials than others (radio-rooms, engine control rooms, accommodation, etc.)

A fire can be successfully coped with, at the initial stage, using the classic means and methods. An important fire will have to be dealt with by inert methods. Protein and synthetic foams will be used. When using water it is recommended to use the spray method (use spray gun).

1.9 Tactics and procedure of fire control while ship is in port.

Fire fighting organization on board consists of several teams. The master of the ship bares the overall responsibility for the operation.

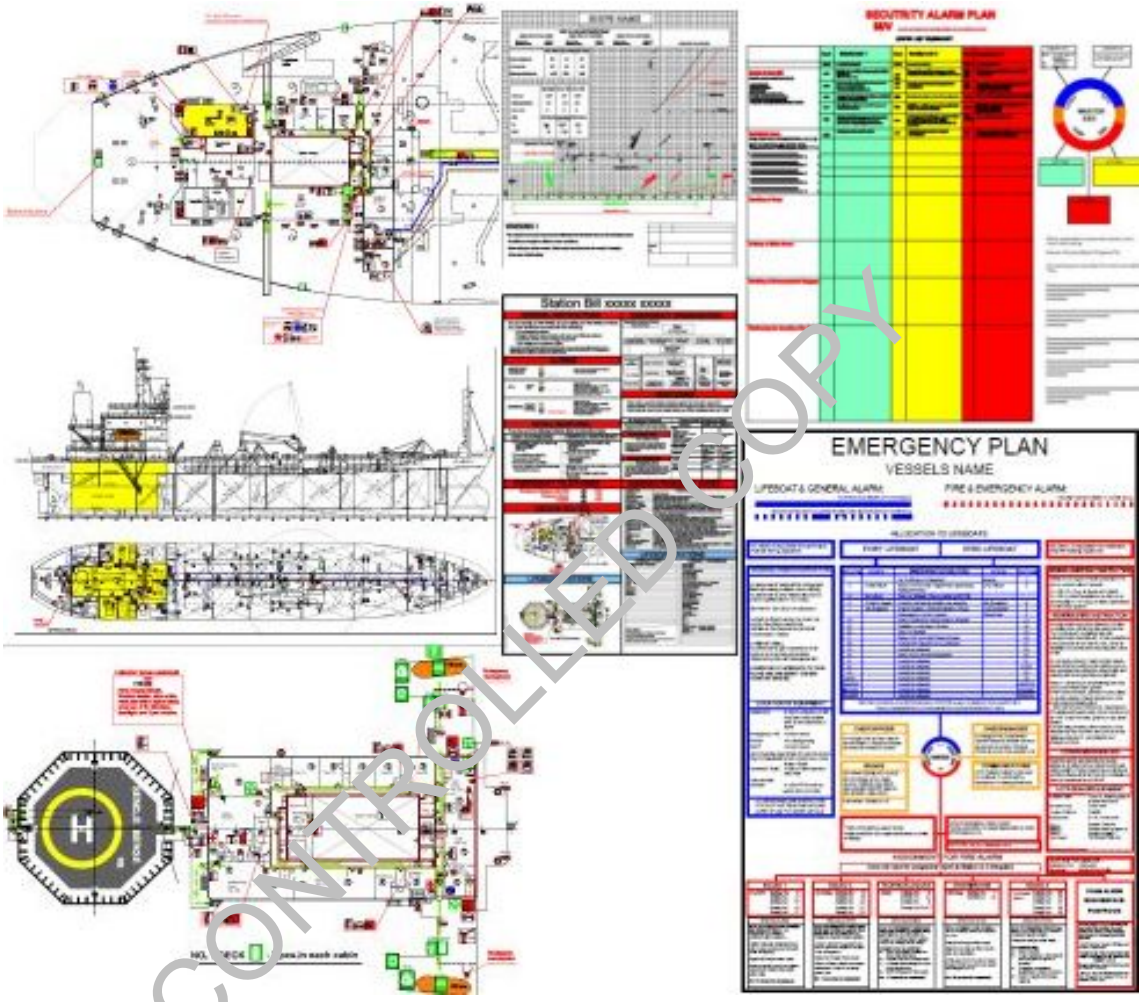
Though duties vary from ship to ship, usually the chief officer will be in charge of operations in the accommodations and deck area, and chief engineer is responsible for operations in and around the engine room. The crew is divided into various teams such as fire fighting, engine room, technical and first aid team.

The organization and jurisdictions of shore based rescue services and the resources available to them will vary from country to country and may involve civilian or military emergency agencies. The way in which the operation is handled will also depend on whether the ship is at sea or in port. Local fire fighting authorities will normally engage fires that occur in port. Fires at sea however will require a great deal more organization, which can include assistance of fire fighting tugs and transportation of fire fighting crew and equipment from sever different stations to the area. Such operations are coordinated at multi- jurisdictional levels.

There are planned courses of action or procedures that are intended to result in the best possible outcome. This involves the placement and coordination of crewmembers or teams in such a way that maximizes their ability to cope with situation. These procedures include:

- Alerting a notifying
- Alarm instructions
- Saving lives
- The emergency escape breathing device
- Limiting the fire
- The use of fire doors
- The use of smoke and fire dampers
- Extinguishing the fire

It is important to alert the bridge, immediately if a fire is detected. This can be done by using automatic or manual alarm systems. The management on board will then have more time to plan and organize the fire fighting operation. On board of every vessel you will find an Emergency plan, explaining the meaning of various alarm signals and your specific duties in an emergency situation. Make sure you are familiar with the Emergency Plan on your vessel.



1.10 Tactics and procedure of fire control while ship is carrying dangerous goods.

Hazardous Materials for Transportation (or "Dangerous Goods") are products and substances that can pose danger to people, property and the environment while being transported.

These dangerous items can include products that obviously pose a safety risk, such as a grill with a large flammable gasoline tank, but many common household items are also labeled as "dangerous" when being shipped.

Seemingly harmless everyday consumer products can be regulated under transport rules due to ingredients that make up the product.

For example:

- Did you know that nail polish, perfume, hand sanitizer, paint and shoe polish can all be flammable?
- Or that make-your-own soda products come with pressurized non-flammable gas?
- And think about all the cell phones and electronic devices that are powered by lithium batteries (yes, batteries are considered dangerous goods.)

Every one of us buys or uses products labeled as a dangerous good on a regular basis, and we may not even realize it.

While these products are perfectly fine for use in our daily lives, when it comes to moving them around the world, we need to be certain they are shipped safely.

The Carriage of dangerous goods and marine pollutants in sea-going ships is respectively regulated in the International Convention for the Safety of the Life at Sea (SOLAS) and the International Convention for the Prevention of pollution from Ships (MARPOL).

Relevant parts of both SOLAS and MARPOL have been worked out in great detail and are included in the International Maritime Dangerous Goods (IMDG) Code, thus making this Code the legal instrument for maritime transport of dangerous goods and marine pollutants. As of 1st January 2004, the IMDG Code will become a mandatory requirement.

1.11 Tactics and procedure of fire control for oil, chemical and gas tankers.

With tones of highly flammable and hazardous cargo and fuel oil on board, tanker ships are accident prone zones having high probability of fire accidents. The frequent cargo handling operations and loading/unloading procedures of hazardous materials make tanker ships highly vulnerable to accidents. Sometimes in spite of taking all safety precautions, accidents involving fire do take place on tanker ships because of unprecedented events.

Tacking fire on tanker ships require strategic planning and systematic approach, along with the least response time. The approach to fight fire on board ships would differ according to the type of the fire, source of fire, and the location of the ship. Mentioned below is the general action that is taken when a fire breaks out on a tanker ship while the ship in a terminal.

Actions to be taken by ship personnel to fight fire on tanker ship in a terminal

As stated by the standard rule for emergency situations, the first thing the tanker ship personnel must do in case of fire on board is to raise the alarm by sounding the recognized alarm signal which consists of a series of long blasts from the ship's whistle. Usually, each of this alarm blast is not less than 10 seconds. However, there is a possibility that the terminal authority might ask the ship to give a locally recognized signal in case of an emergency. In such cases, the stated emergency alarm should be raised.

As soon as the signal is sounded, all cargo, bunkering and ballasting operations, must be stopped by the ship. The main engine and the steering gear must also be brought to a stand by position. All other cargo operation equipment for tankers must also be stopped immediately if they are in use.

Once this is done, the ship's crew will take the responsibility of fighting the fire under the leadership of the ship's captain or any other officer appointed for the task. The procedure for fire fighting at the terminal remains the same as that when the ship is at the sea. An additional team/ group might be formed for assistance in fire fighting or for disconnecting and arranging hoses from the manifold. All resources and human efforts available are used to stop the fire as soon as possible.

If the situation requires, the master of the ship might ask assistance from the terminal authority. The ship's fire fighting team must make a united effort with the professional fire fighters from the shore to bring the fire under control.

Actions to be taken by the terminal to fight fire on tanker ship

On hearing the emergency alarm from the tanker ship, the terminal in-charge would immediately inform the control room. The control room will sound the terminal fire alarm, inform the port authority, and commence shutting down of loading, discharging, bunkering or ballasting procedures immediately.

The terminal personnel, according to the severity of the situation, can also ask the adjacent or nearby ships to shut down all loading, discharging, bunkering or ballasting procedures. In order to maintain a level of utmost safety during emergency situations, the terminal authority might ask nearby ships to disconnect all their metal arms and hoses and keep their engines and steering gear ready.

The terminal in-charge, after discussing with the control room officials, might send professional fire fighters or fire fighting tugs to assist in the emergency process. The terminal might also ask outside assistance such as civil fire brigade, medical aids, rescue launches, police etc. if the situation requires.

Fighting fire on tankers is not an easy task especially when the fire is big and has a potent fuel source nearby. The ship and terminal personnel must work with combined team effort to bring the fire under control before it becomes a major threat to the ship and the terminal

1.12 Use of water for fire extinguishing, the effect on stability, precautions and corrective procedures.

Water fire extinguishers are not suitable for all types of fires and can cause serious damage if used incorrectly, this article explains where and when water fire extinguishers are safe to use and what you need to be careful of.

Water fire extinguishers can be used for Class A fires i.e. solids only, such as wood, paper, plastics and fabrics. They are not suitable for controlling Class B liquid fires e.g. paraffin, petrol, oil based fires, including chip pan fires, or on electrical fires and where electricity is involved unless the supply can be disconnected first. Water fire extinguishers are colour coded with a red label. Do not be confused with the normal red paint finish on the main body of most types of fire extinguisher. The fire extinguisher works by water under pressure cooling burning material.

How to use a water fire extinguisher:

1. Direct the jet at the base of the flame and keep it moving across the area of the fire.
2. Seek out any hot spots after the main fire is extinguished.
3. A fire spreading vertically should be attacked at its lowest point and followed upwards.

Vessel Stability

One thing to remember is that a vessel is made of steel; therefore, a compartment on fire is similar to an oven. It radiates the heat back into the center of the compartment, unlike a structure fire, which tends to absorb the heat. Using minimal water is important. More than a few vessel fires have been extinguished not through firefighter extinguishment but by the vessel's rolling or sinking as a result of applying so much water. A basic rule of thumb for all officers in charge (OIC) is that once you start to flow water on or in the vessel, you need to start pumping the water off somehow. Most fire officers don't realize they have a stability problem until it is too late. They then have to rush and try to get their

personnel off the vessel before it sinks or rolls over. A vessel normally will not roll over slowly. It will start to list (lean) to one side and then abruptly roll.

Trying to counteract a listing vessel by moving deck materials, counter flooding, and so on can capsize a vessel because of "free surface effect," the unimpeded movement of water inside a vessel. For example, if a vessel is leaning to the port, the water will tend to start to collect there. If you try to counterweight the vessel on the starboard side, the water on the port side will suddenly shift, basically doubling the effect. Now you would have the vessel slowly returning to even keel and suddenly rapidly list to the opposite side at an angle greater than before, and that momentum may roll the vessel. It is highly recommended that a salvage engineer or naval architect with firefighting/salvage experience be present at the command post at marine fires to make recommendations to the OIC.

1.13 Communication and co-ordination during fire-fighting operations.

Do not rely on your standard fire command radios for communication with personnel onboard the vessel. Communication onboard the vessel may be sporadic at best. Most fire service radios do not operate well within the vessel. You may be forced to use runners to communicate with personnel inside the vessel's hull. You can position a person onboard the vessel with a radio outside the hull with a runner in full turnout gear and SCBA. Communicate with this person by radio to relay important information to the firefighters inside the vessel. Your standard evacuation call methods will probably not work because firefighters inside the hull will not be able to hear the call. SCBA time may be very short.

Fire-fighter's radio communication is additional to the fire-fighters outfit and intended for the Fire Party. Therefore, the total number of these radios to be carried on board will depend upon the number of fire parties detailed on the Muster List rather than the number of fire-fighter outfits.

Each Fire Party must have at least two of these dedicated radios and as fire-fighters may need to use Direct Mode Operation during fire-fighting operations or if the Fire Party consist of more crew members than the actual fire fighters. The purpose of these fire-fighter radios is to provide a dedicated means of communication between a team of fire fighters entering the space, and the crew member located outside the space who is assigned to control this team.

In this part and in the others, communication is a key factor for success. Communication is not only established between the team leaders and the captain, but between the team members and the team leaders. Good flow of communication enables the involved elements to carry out their designated tasks according to the prevailing situation (Rushbrook, 1979). Through communication, the team leaders are given reports of the situation of the fire and the problems encountered from the fighters. Consequently, they are able to give proper guidance and instructions after they have conducted an assessment of the situation. Nowadays, certain breathing apparatus are equipped with a radio. Similarly, the team leaders provide enough information to the captain in order for 33 him to assess the situation and provide instructions accordingly to the team leaders. Lastly, in the author's opinion, communication between the emergency teams should also be established, as co-operation may be needed to achieve better performance.

1.14 Ventilation control including smoke extractor.

Ventilation promotes the supply of oxygen to the fire. Depending on the report made by the crewmember at the discovery of the fire, the officer of watch should order all mechanical ventilation and vent openings to be closed. Normally, this order is only given by the captain.

However, it is desirable that the officer of watch immediately close down the ventilation throughout the ship if the report is serious. If the fire is located, only the supply of air to the affected area (or compartment) is to be cut off to diminish oxygen. A further monitoring of the ventilation can also be conducted to help fighting the fire but only if it is safely used.

Ventilation is covered in SOLAS in many aspects. First and foremost the structural elements and particularly ducting and its routing through bulkheads and decks are considered. That this should be so is understandable given that any penetration of bulkheads and decks are potential conduits for fire and flooding. Most of this will be addressed at the design stage and as part of the construction will be covered by the Safety Construction certificates.

Ventilation not an option

As most firefighters know, one of the first things you do at a structure fire is ventilate. This most likely would not be an option at a vessel fire, especially if the fire is in the engine room. Imagine standing on the roof of a four-story building with one steel-encased stairwell down to the basement and only one door present at the roof. Now imagine that the basement has several feet of diesel fuel burning and the only way into the area is to properly open that door and head down that stairwell filled with superheated gases. That is what it generally

is like trying to enter an engine room that is burning out of control onboard a vessel.

Whether to use solid bore nozzles/streams or variable nozzles has been the subject of much debate. Technically, either will suffice during a shipboard fire. But one thing is certain: Going to a fog stream inside a vessel can make those inside feel like steamed lobsters. You will almost instantaneously regret going to a fog stream and will learn that lesson the hard way, probably with several steam burns to drive the point home.

Case in point: During our training courses, firefighters usually have the opportunity to try to extinguish an interior fire using the firefighting methods they use for structural firefighting. In most cases, the team does a hasty retreat as soon as the members attempt to extinguish the fire because they attempt to use techniques designed for a structural fire. If they try to use a medium to wide fog pattern to keep themselves cool or attempt to use a continued stream on the fire, they will generally end up producing more steam than they were hoping for. The compartments will rapidly fill with steam. We all know what happens when you put water on an extremely hot piece of metal. The same principle applies here, only on a larger scale. We then take the firefighters back into the facility and show them how to extinguish the fire using the proper techniques and minimal quantities of water.

Cruise ship ventilation is responsible for removing maintaining air quality in that on top of air circulation, ventilation systems remove odors, exhaust, contaminants, as well as other airborne hazardous. To be effective all components of ventilation systems such as ducts, motors and filters must work

properly to be effective. The root cause of shipboard issues are a result of salt water spray which corrodes internal components as well the location of equipment which is often in tight spaces. Without inspection and preventive maintenance the result is a shortened asset lifecycle and greatly reduced energy efficiencies.

1.15 Control of fuel and electrical systems.

On board a ship there is fuel oil, lubricating oil, hydraulic oil - all very combustible and the most likely nourishments of an engine room fire. Gard surveyors have met crew members who do not consider lubricating oil and hydraulic oil to be fire hazards, as such oils are seen to be difficult to light. That is, however, only a question of temperature. In an oil fire it is the gas above the liquid that burns, and if heated sufficiently by a fire, lubricating oil and hydraulic oil also become volatile and fire-hazardous.

All oil supply systems in the engine room are constructed in accordance with classification and SOLAS rules, and there are built-in protections which the crew should be aware of, understand and respect. Valves in fuel oil supply lines from day tanks are fitted with remote controls, operated from a location outside the engine room casing, so that fuel supply may be cut in an engine room fire. These devices are regularly inspected by class, flag state and port state inspectors and are normally in good working order. It is also important that such remote closing arrangements are clearly marked for the oil supply lines they serve, in order not to close the fuel to the wrong machinery. One may want to stop the main engine in a fire situation, but possibly not an auxiliary diesel engine supplying power to the fire pumps, for instance.

One breach of safety which Gard surveyors see on board most vessels they inspect is that the lower valve of the level glasses of oil tanks is forcibly kept open. Class and state authorities seem to overlook this item, although it is clearly stated in classification and statutory rules that such a valve is to close automatically.

Action in case of Engine Room fire at sea

1. Raise the alarm.
2. Inform the master
3. Reduce the vessels speed & Engage manual steering. Display NUC (NOT UNDER COMMAND) lights, Weather reports, open communication with other vessels in the vicinity and send urgency signal.
4. Close all ventilation, fire and watertight doors.
5. Muster all crew- take a head count. Emergency fire p/p running.
6. Isolate all electrical units. Commence boundary cooling.
7. Fight fire by conventional means.
8. Main fire party to be properly equipped. Back up party ready at all times.
9. C/O not to enter as he monitors progress and communication with the bridge. Proper communication between bridge and engine room. Keep bridge informed accordingly of sequence of events.
10. At all times fire fighters to be well equipped with breathing apparatus and fireman suit. Checks on apparatus must be carried out prior to entering space.

For a fire to propagate in an engine room, it needs material for combustion. Oil should not be allowed to accumulate in drip trays, gutters and bilges, so a high level of cleanliness will normally be associated with a high level of fire safety.

Drain pipes from gutters to oil collecting tanks should be kept open, oily rags should be disposed of in a correct manner and engines and floor plates cleaned regularly. Oily remains in bilges and in other areas below floor plates may at times need chemical cleaning to be removed.

In some ships there is a large collection of used spare parts and items which are "nice to have". Gard surveyors have seen large collections of plastic sheets, cardboard, wooden planks, used paint tins, etc. being stored in fire- prone areas. "Good housekeeping" is a key word! Discard combustible materials, remove outdated equipment that may hinder access in a fire situation and enforce a high level of cleanliness. It is not particularly smart to store combustible materials behind an electrical switchboard, close to the exhaust pipe of a diesel engine, in the vicinity of a boiler furnace, and next to rotating machinery.

Sources of ignition

The sources of heat most likely to start a fire in the engine room are hot exhaust pipe and engine surfaces, bearings of rotating machinery heating up and defunct electrical equipment. Heat sources can of course also be introduced by human error, as by for instance dangerous use of electric tools and welding equipment.

Insulation of exhaust pipes is often found to be defective, especially in the vicinity of the diesel engines, where removal of insulation is needed during engine maintenance. Also, flange connections and steel supports of exhaust pipes may often be inadequately insulated, as well as indicators and other instruments fitted. Look for signs of hot areas, such as paint discoloration and

reddish rust surfaces. New regulations are now established, valid for all ships from 1st July this year.

Electrical installations will always represent a certain risk of sparks and fire, although the risk is reduced by the use of quality safety devices and close adherence to valid regulations. When a vessel is delivered from the newbuilding yard, the electrical installation is normally in good condition, well tested by competent personnel. Thereafter the authorities' control of electrical installation on board a ship is very lax, far below the level imposed on land-based industry and private homes. In reducing the number of crew on board, the position of electrician has disappeared.

The electrical installation on board a ship is regulated by class and SOLAS rules. A "megger test" by crew or shipyard and a superficial visual inspection by the class surveyor is often all the attention the electrical installation receives. Thermographical examinations are considered a much better means for checking the fire risks of electrical installations, and such technology is now easy to obtain.

Gard surveyors see a lot of dangerous, "home-made", electrical work on board older vessels. It must be emphasized that only qualified personnel should be allowed to work on electrical installations, only quality electrical fittings should be used and valid standards should always be followed.

All rotating machinery may also represent a source of sufficient heat to light a fire, first of all by bearings of pumps, etc., heating up. Alertness and proper maintenance are key words.

A crankcase explosion is a particular danger when main bearings of a diesel engine crankshaft become damaged. The premature opening of crankcase doors following an oil mist or high bearing temperature alarm has been the cause of more than one engine room fire.

1.16 Fire precautions and hazards associated with the storage and handling of materials (paints, etc).

Paint room

Lighting in paint storage areas should provide a safe working environment. The lighting needs to be reliable and the luminaires must be maintenance-free and achieve a certain level of light intensity.

Different areas on a ship have particular lighting demands

Paint storage is a small but special area onboard a marine vessel. In these areas, paint and thinners are typically stored and handled. Special requirements on lighting installed in these areas include explosion-protection and resistance to chemical gases/vapours. In addition to these requirements, the fixtures must be easy to install, maintenance-free and should provide sufficient light intensity with appropriate colour rendering (CRI) in order to avoid incorrect colours of paint from being selected.

Explosion-proof

As soon as the luminaires are installed in areas where potentially explosive gases occur, the installed fixtures must be approved according to the explosion classes required for that area.

As per (SOLAS Reg. II-2/13)

Paint lockers and flammable liquid lockers shall be protected by an appropriate fire-extinguishing arrangement approved by the Administration.

Paint lockers and flammable liquid lockers of deck area 4m2 and more shall be provided with a fire-extinguishing system enabling the crew to extinguish a fire without entering the space.

Fixed arrangements as specified below

1. CO2 – system, designed for 40% of the gross volume of the space.
2. Dry-powder-system, designed for at least 0.5 kg powder/m3.
3. Water spraying system, designed for 5 l/m2, minimum.
4. Water spraying systems may be connected to the ship's main system.
5. Other systems than those mentioned above may be accepted.

6. For lockers of deck area less than 4 m2 CO2 or dry-powder fire extinguisher(s) may be accepted.

1.17 Management and control of injured persons

First Aid on Board

First aid is treatment aimed at preventing the death or further damage to health of an ill or injured person perceived to be in a life-threatening condition. All crew members should receive training in first aid.

Step 1

Assess the situation: what do think happened and is there still danger?

a. If giving first aid will expose you to danger, do not do it: call or go for help.
b. If a person is still in danger, remove the danger or the person before giving first aid.
c. If bystanders are in danger, warn them.

Step 2

If you are alone, shout for help.

Step 3

Choose the best place for first aid.

a. On the spot?
   - Not if fi re is present.
   - Not if there are potentially dangerous gases in the atmosphere.
   - Not if there are other risks at the site of the accident.
b. In the ship's infirmary (sick-bay) or in a cabin?

- Not if the delay in moving the person is dangerous.

Step 4

If there are several injured people, prioritize.

a. Attend first to any unconscious person.
b. If there is more than one unconscious person:
   - Check each for pulse and breathing;
   - Begin resuscitation of a person who s not breathing or has no detectable heartbeat.
c. Attend to conscious patients:
   - Treat bleeding by applying pressure to the wound;
   - Wait until the patient has been moved to the sick bay before dealing with other injuries, unless you suspect spinal injury.

What not to do when giving first aid

- DO NOT GIVE FIRST AID if you have doubts about your ability to do so correctly.
- DO NOT ENTER AN ENCLOSED SPACE unless you are sure it is safe.
- DO NOT MOVE THE PERSON without checking for:
  - Spinal injuries
  - Fractured long bones.
- DO NOT GIVE THE PATIENT ANYTHING TO EAT OR DRINK (especially alcohol).

SHAKE AND SHOUT

– Before starting basic life support, shake the patient vigorously by the shoulder or leg and at the same time shout or call the patient's name if you know it.

AIRWAY – IF BLOCKED, OPEN IT

– Remove any loose-fitting dentures.
– Check for obvious spinal injury.
– Tilt the patient's head back by exerting pressure on the upper forehead with one hand.
– Use two fingers of the other hand to raise the chin.
– If spinal injury is suspected, tilt the head back, but only enough to keep the airway open, and pull the lower jaw forward rather than raising the chin.
– Prepare for the possibility of mouth-to-mouth rescue breathing by making sure the thumb and index finger of your hand that is on the patient's forehead are free to pinch the patient's nose.
– Use your fingers to remove any visible obstructions from the patient's mouth and throat.

BREATHING – IF STOPPED, RESTART IT

– Nook, listen, and feel for signs of regular breathing:
  - Nook for chest movements;
  - Listen for sounds of breathing at the patient's mouth;
  - Feel for exhaled air on your cheek.
– If there are no signs of regular breathing:
  - Send or shout for help;
  - Give two rescue breaths (see below).

- If normal breathing resumes:
  - Place the patient in the recovery position.
- If normal breathing does not resume:
  - Check again for obstruction to the airway;
  - Check that the head is tilted enough and the chin raised enough;
  - Try again to restore breathing with two strong rescue breaths.
- If normal breathing still does not resume, check the blood circulation.

MOUTH-TO-MOUTH RESCUE BREATHING

- With one hand under the patient's neck keep the patient's head tilted as far back as it will go – unless you suspect spinal injury, in which case use minimal tilt.
- Place the heel of your other hand on the patient's forehead with the thumb and index finger facing towards the nose.
- Pinch the patient's nostrils with your thumb and index finger to prevent air from escaping.
- Open the patient's mouth, take a deep breath, and then form a tight seal with your lips over and around the patient's mouth Use a Guedel airway if available.
- Insert the Guedel airway between the patient's jaws with the concave curve facing upwards (towards the patient's head).
- Push the airway gently into the mouth while rotating it 180° so that the concave curve faces downwards and the airway points towards the patient's lungs. Leave the airway flange outside the teeth.
- If it is not possible to open the patient's mouth or to form a seal around it with your mouth, apply mouth-to-nose rescue breathing.

- Breathe into the patient's mouth at a rate of one breath every five seconds or 12 breaths a minute, completely refilling your lungs after each breath.
- Continue until the patient's chest rises and falls with each rescue breath and you feel the patient's exhaled breath on your cheek.
- If you feel no air on your cheek, check if there is a foreign body in the patient's throat and, if so, remove it with your fingers before resuming rescue breathing.

MOUTH-TO-NOSE RESCUE BREATHING

- Use mouth-to-nose rescue breathing if any one of the following conditions applies:
  - The patient's mouth cannot be opened;
  - A tight seal cannot be obtained around the patient's lips;
  - An obstruction cannot be removed from the patient's mouth;
  - The patient has been rescued from water and the rescuer needs to use one hand to support the body and is therefore unable to use that hand to close the nose for mouth-to-mouth rescue breathing.
- Keep the patient's head tilted back with one hand: use the other hand to lift the patient's lower jaw to seal the lips.
- Take a deep breath, seal your lips around the patient's nose and breathe into it forcefully and steadily until the patient's chest rises.
- Remove your mouth and allow the patient to exhale passively.
- Repeat the cycle 10–12 times per minute.

EYE INJURIES

Eye injuries can result from a number of causes, including a foreign body, a direct blow to the eye, laceration, exposure to a chemical, and a burn. The first

step in dealing with an eye injury is to record a full account of the circumstances of its occurrence followed by a careful eye examination.

How to examine the eye

- Have the patient lie down, with the head supported and slightly tilted back.
- Check that you have:
  - Good lighting (an overhead light or strong daylight);
  - A powerful hand-held torch;
  - A magnifying glass (preferably a × 8 loupe);
  - Soft paper tissues;
  - Moist cotton wool swabs or buds;
  - Fluorescein eye stain strips;
  - anaesthetic eye drops (0.5% solution of tetracaine hydrochloride):
    - never put more than one dose of anaesthetic into the eye;
  - antibiotic eye ointment (1% tetracycline hydrochloride ointment):
    - do not use the same tube of eye ointment for more than one patient or for more than one course of treatment.
- Compare the injured eye with the other eye, using a diagram to record your findings.
- Check if the patient can open the affected eye and can keep it open.
- Test for vision:
  - test for vision before any bright light is shone on the eye or any drops are used;
  - ask the patient to read from a newspaper or book;
    - if reading is not normal test with larger print, such as a newspaper headline or book title;

- if the patient still cannot read print hold up two or three fingers and ask the patient to count them;
- if counting fingers is not possible, check if the patient can tell light from dark.

– Use a darkened room to check the size of the pupil and its reaction to light:
  - if there is corneal damage, the pupil is often small (1–2 mm in diameter) and it can be hard to see it becoming smaller in response to light.

– Examine the sclera (the white of the eye) for damage or foreign bodies:
  - gently hold apart the eyelids with the fingers and ask the patient to look up, down, left and right;
  - make sure you see clearly into each corner of the eye.

– Inspect the inside of the lower lid by gently pulling it down, with patient looking up.

– Inspect the inner surface of the upper eyelid for damage or foreign bodies; to do this it is necessary to roll back the upper lid:
  - with the patient looking down, place the index finger of one hand or a matchstick across the upper lid while grasping the eyelashes firmly but gently between the index finger and thumb of the other hand (Figure 5.1);
  - pull gently upwards on the eyelashes, pressing down with your index finger or the matchstick and folding the eyelid back over it;
  - the lid will return to its normal position if the patient blinks once or twice.

– Inspect the cornea (the transparent front part of the eye that covers the iris, pupil, and anterior chamber) and surrounding area:

- use the loupe, and slant light across the cornea, which will help show up any abnormality;
- the cornea should be clear;
- any area of cloudiness or opacity, or the presence of foreign bodies, should be noted;
- the surrounding sclera may be reddish, indicating possible irritation of the cornea;
- remove any obvious loose foreign bodies (see section below, Loose foreign bodies).

– Stain the eye with fluorescein to show up any damage to the cornea or conjunctiva:

- with the patient looking up, draw the fluorescein paper strip gently across the pulled down lower lid;
- have the patient blink a couple of times to spread the dye over the eye;
- wipe away any excess dye from the eyelids;
- areas of corneal or conjunctival damage will be stained green;
  - Note any such areas on a drawing of the eye in the patient's chart.

1.18 Procedures for co-ordination with shore-based fire fighters.

Many shore-side fire departments, responsible for matters dealing with marine firefighting and other hazards, may not be as prepared as they should for the many dangers associated with vessel fires. Fire departments well versed in shipboard firefighting do exist, but they are few and far between.

A large commercial vessel has been compared to that of a large building, with most of its volume in the basement levels. That alone should give rise to concern. A container vessel, for example, may have an internal depth of hull approximately seven stories, with access through an entry point in the hull one deck below the uppermost deck, commonly known as the weather deck. Above the weather deck, you'll usually find the accommodations, consisting of up to eight decks. Together, these decks make a structure equivalent to a building with nine aboveground and six below-grade stories.

As with buildings, commercial ships vary in design, materials and general layout, further complicating the fire attack. Many large commercial vessels contain all the elements of a small town: heavy industrial units, high bay warehousing, a hotel, leisure facilities, workshops, bulk oil storage, offices and other ancillary facilities.

Who Responds?

When a vessel's master reports a fire onboard the vessel, a number of agencies may respond to the call. If the vessel is at sea or at anchor, the Canadian Coast Guard or U.S. Coast Guard respond, assisting from the waterside by combating the fire from sea and evacuating personnel from the involved vessel, commensurate with their level of training and available equipment.

For a fire in a vessel tied up alongside, the local fire department should respond with all the necessary/available resources based upon the size/severity of the fire, the hazards present and the possibility of the incident expanding.

Note: It's not acceptable for fire departments with limited experience and exposure to marine emergencies to turn a blind eye.

I have heard fire officers cite budgetary constraints, liability concerns and a general lack of experience as reasons why their department is reluctant to incorporate marine firefighting as part of their training curriculum. Fire departments responsible for providing fire protection to vessels within their jurisdictions shouldn't hesitate to develop and implement a marine emergency response program for their members. Recognizing that your department has a responsibility to the shipping industry is a good start.

Challenges of Shipboard Firefighting

Marine firefighting is unarguably one of the most challenging of all firefighter disciplines. If you've ever responded to a fire on a large commercial vessel, you may have experienced some of the following:

- As you work your way through the vessel, you think for a moment that you're slipping on an oily deck, only to discover the soles of your boots are melting.
- You advance on what you believe is the seat of the fire, the heat almost unbearable, only to discover this is just an adjacent compartment and the main body of the fire is inaccessible from your location.
- The thermal imaging camera shows all bulkheads glowing, indicating the fire may have spread to more compartments, but fails to display an opening in the deck with a 10-meter (33-foot) drop.
- You arrive on scene to find thick black smoke coming from the stern of the vessel. The ship's crew isn't on scene to meet you, and you don't

have access to the vessel. As you establish command, explosions occur, sending debris rocking over the vessel.

- Broken English from a deck officer indicates two crewmembers are unaccounted for.
- You have an action plan in place and your recon team has completed its size-up, provided the incident commander (IC) with the ship's fire plans and located and brought one of the ship's officers back to the command post. Power and ventilation to the area have been confirmed shut off, your teams have been briefed and the hoselines are laid. As your teams proceed below the weather deck, all communication is lost. You don't know when your team is on air, where they're located and what, if any, progress is being made.
- A runner reports not all power has been isolated and the attack team requests clarification and confirmation prior to proceeding further.
- With the command post established on the jetty, a number of agencies arrive to offer assistance and demand to know the status of the situation.
- You arrive on scene to discover the vessel on fire is underway; in other words, the vessel is moving under its own power.

Consider some other specific challenges. You may arrive on scene only to find that the vessel reporting the incident is at anchor. Where are the doors when a ship is at anchor? If you're lucky, there might be an accommodation ladder angled down the side of the ship. Does your preplan address the mode of transportation designated to transport your teams of firefighters to the vessel? Can you imagine climbing a narrow, unsupported accommodation ladder with all your firefighting gear while the ladder bounces up and down several feet as the vessel pitches and rolls?

If you're fortunate enough that the vessel is docked or tied alongside the pier or jetty, you still face a number of challenges, including:

- Interfacing with the ship's crew;
- Communication issues;
- Hazmat;
- Coordinating multiple agencies arriving on scene;
- Search and rescue;
- Limited access, narrow access routes and confined spaces inside the vessel;
- Unprotected deck openings;
- Moving equipment;
- Electric shock hazards;
- Confusing interior arrangement, and
- Ventilation and vessel stability.

The incident complexity may vary, but in most cases, success is determined by the department's level of preparation, training and general knowledge associated with the marine environment.

Establish a Plan

Realistic pre-fire plans are a crucial part of any marine emergency response program. The numerous resources and specialists required at a major shipboard fire can rapidly turn a command post into a chaotic area. The time to prepare for a vessel fire is before it occurs, when you have adequate time to identify resources, prepare special equipment, and coordinate, review and practice the response plan.

Preplanning involves the following steps:

- Determine which commercial and private vessels are present in your community, including their location and quantity, and how often they frequent your port; previous incident history; and surrounding exposures and hazards. Canadian and U.S. port authorities are good resources for this information.
- Conduct a hazard analysis to determine the probability of a vessel fire. Factors that influence fire probability include the vessel's construction, her cargo, terminal operations and/or shipyard operations. Identify the hazards that could threaten the crew, property and the environment in the event of a fire. You should know what emergency response resources will be required, including personnel, equipment and supplies.
- Develop written shipboard firefighting guidelines and procedures. Guidelines and procedures can include but are not limited to initial response considerations (water supply, apparatus positioning, staging, harbor security, etc.), marine firefighting team operations and fireboat operations.
- Conduct pre-fire surveys on vessels that frequent your ports on a regular basis. NFPA 1405: Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires highlights how to conduct a pre-fire survey, which is extremely useful in the event of a fire. This is also an excellent opportunity for your fire department to begin opening the lines of communication with the vessel's crew, and, more importantly, the vessel's master. Many vessels sailing to and from Canadian and U.S. ports are foreign flag vessels, which means the crew may not speak English. For the most part, masters and mates should have a basic working knowledge of English, but you should know where to locate interpreters if required.

Preplanning also encompasses training for your personnel. Due to the broad nature of marine firefighting, it may prove beneficial to divide the skills into three distinct levels, similar to hazmat training standards: awareness, operations and technician.

A typical marine firefighting program begins with a 40-hour, site-specific marine firefighting introductory course. This should be followed by regular marine environment familiarization of vessels, terminals, shipyards, etc. Fire department personnel should be tested on a regular basis to ensure all practical shipboard firefighting skills are maintained to an acceptable standard. Like many other firefighting disciplines, it takes many hours of training to prepare for a vessel fire.

First-Arriving Actions

Our natural response to any fire is to act immediately, and this is particularly true when responding to structural fires that present synonymous and sometimes predictable characteristics. This isn't the case with large fires on vessels. Approach a large vessel fire like you would approach a hazmat incident. As with hazmat incidents, the actions the IC takes in the first 10 minutes of a vessel fire usually dictate the success of the next hour.

Note: What's described here reflects strategies for fires in vessels tied alongside. Unless your department has the resources and experience to respond to a fire on a vessel that is out to sea or anchored, you will be overstepping your boundaries.

Due to jurisdictional issues, establishing command may not be as cut and dry as you may think. If you have overlapping responsibilities between the vessel crew, the fire department and the port authority, you may be able to overcome problems by successfully using a unified command structure. That said, the unified command structure must be supported with established memorandums of understanding with other agencies, and the vessel master should be familiar with the incident management system.

The first-arriving fire officer must consider a wide range of actions in deciding how best to deploy resources. Marine fires require a strong, centralized command. To prevent freelancing, objectives must be prioritized and agencies organized. The IC must gather all pertinent information, including what has occurred and what will be occurring, before developing the action plan.

The fire control plan is one of the most important resources on a large commercial vessel. It provides information such as the general layout of the vessel, fire-suppression systems and vessel construction features. Unless your members are very familiar with a particular vessel, the fire control plan will be a very valuable tool. Many port authorities make it mandatory for the vessel fire control plan to be placed in a watertight container adjacent to the gangway for shoreside fire departments. If this location isn't used, the fire control plans must be clearly marked and kept outside the deckhouse. Fire control plans are also located on or near the bridge or displayed on a bulkhead.

Initial actions should address rescue of endangered persons, confinement, exposure protection and preventing fire spread. The strategies and tactics may vary depending on the situation and the fire's location on the vessel. Confining

the fire to the compartment of origin and preventing fire spread can be accomplished by establishing boundaries. Hopefully, the ship's crew has taken immediate action prior to the fire department's arrival, confining the fire, closing doors and hatches and isolating power and ventilation to the affected area.

Ventilating a ship fire is a delicate procedure. Although the basic principles of fire ventilation may be applied to ship fires, it may not be easy to establish a path for the fire gases without causing fire extension or creating flashover/backdraft conditions. In short, conduct ventilation practices only after you have consulted with the vessel master, officer or engineer and when you are certain the process will not create additional problems.

If the fire has not been confined, the IC must establish fire boundaries. Position charged hoselines in areas that would be directly affected by heat transfer. In some circumstances it may be possible to prevent the spread of fire by removing combustibles in designated areas from direct contact, thus preventing additional fuel sources from igniting through heat transfer. This is referred to as "boundary starvation." Boundary control techniques are a very important consideration for any fire aboard a large vessel. Unfortunately, it seems many fire departments don't place enough emphasis on this tactic.

Fire Attack Considerations

A fire in a vessel's compartment is basically a fire in a metal box. The fire spreads in six directions through a ship's structure. Heat may be transferred through the metal bulkheads and the deck or deckhead to adjoining compartments. The fire-resistance rating varies with the type or class of bulkhead. A class "A60"-rated bulkhead is composed of steel or equivalent

metal, preventing smoke and flame from penetrating, or passing through, for a period of 1 hour.

On commercial vessels, the fire-resistance rating of bulkheads is divided into three classes: A, B and C. The structural fire protection and fire load for a space can be related to the classification during vessel construction and design. The letters relate to incombustible material with the numbers relating to the amount of insulation required on the bulkhead to prevent the rise of temperature on the non-fire side of a bulkhead with the corresponding time in minutes.

False ceilings, commonly found in a ship's accommodation areas, can conceal voids through which ventilation ducts and other services run. These void spaces may be subdivided by smoke barriers, but if this space has been penetrated, fire can spread into adjoining spaces.

Power and ventilation should be isolated prior to commencing any firefighting operations. Electrical power and ventilation can be isolated from the main control room. The ship's crew should accomplish this task.

The usual fire department tools and supplies can be used to mitigate a ship fire. Standard equipment consists of, but isn't limited to, thermal imaging cameras, piercing nozzles, distributor nozzles, dewatering pumps and foam proportioning equipment.

Preparation Is Key

Like other industries, the shipping industry continues efforts to improve its safety record by incorporating new technology such as better fire-suppression systems, fire-alarm systems and firefighting equipment. However, fires still

occur, regardless of technological changes and improvements. In 2006, a discarded cigarette butt on a stateroom balcony led to the death of one passenger and injured 13 more on the cruise ship Star Princess.

Since it's virtually impossible to eliminate all risks associated with shipboard fires, the need for a well-trained, effective emergency response capability will always exist. Even when all the plans have been prepared and all personnel are trained to an acceptable standard, it's advisable that the IC should be prepared for the unexpected. No two ships are identical, and no two incidents will be exactly the same.

One thing is certain: The fire will either be extinguished, or it will eventually burn itself out. The question is how and by what means. A well prepared attack, with a carefully thought out preplan and coordinated resources to support your attack, is essential. Proper training of your personnel is imperative in providing safe and effective management of a shipboard fire. Be proactive, not reactive.

2. Organize and train fire parties

A fire drill is a method of practicing how a building would be evacuated in the event of a fire or other emergencies. Usually, the building's existing fire alarm system is activated and the building is evacuated as if the emergency had occurred. Generally, the evacuation is timed to ensure that it is fast enough, and problems with the emergency system or evacuation procedures are identified to be remedied.

The purpose of fire drills in buildings is to ensure that everyone knows how to get out safely as quickly as possible if a fire, smoke, carbon monoxide or other emergency occurs. People need to recognize the sound of the fire alarm.

Before regular fire drills were instituted, a fire that had a major impact broke out at the private Catholic school Our Lady of the Angels in 1958, in Chicago, Illinois, US. Children on the second floor were trapped there, with neither teachers nor pupils knowing how to get out of the building safely. Many children jumped out of windows, and many were killed as they could not make their way to an exit. Although the school had passed a fire inspection two months before, and had the number of fire exits and fire extinguishers required at the time, it lacked smoke detectors or adequate fire alarms, and was overcrowded.

The need for fire drills was recognized; monthly fire drills were put in place after the Our Lady of the Angels fire. It was found in a later study that education on fire also helped to prevent it: people started to learn more about what started fires, and what to do in the case of one starting. They were also aware of the hazards that allow a fire to start. Within a year of the fire, many of the hazardous conditions found in Our Lady of the Angels had been eliminated in thousands of schools around the United States.

2.1 Preparation of contingency plans.

The “Contingency Plan” outlines the procedures, which shall be followed when a Company vessel is involved in an emergency (critical) situation and/or marine casualty.

Emergency (critical) situation is situation while the ship, including crew and cargo and environment, are being jeopardized.

The aim of this manual is to ensure timely response and that such response is adequate to meet the size and nature of such a casualty and thereby, as quickly as possible, to remove the threat of serious escalation of the situation. Additionally, to define the records to be kept as objective evidence for all events and response actions taken onboard and ashore in connection with the casualty.

It is essential that this plan is activated promptly when needed, because speed may be vital if escalation to more serious situation is to be prevented.

Master's Authority and Responsibility In all cases where:

- Human life is in danger
- Damage or loss of the vessel or cargo is threatened
- Risk of damaging the environment (pollution) is imminent

In cases when it is difficult to estimate whether the situation is critical or not, the muster will always declare situation as critical.

The Master must take all proper precautions immediately, without restraint, for the safety of the vessel and all personnel on board.

At sea, the responsibility for action rests with the Master and his Officers. Where a casualty occurs in territorial waters or port limits, the authority and/or the port authority may be involved and the Master's freedom of action may be thereby constrained. This would be particularly so if the hazards relevant to the casualty could put third parties at risk. In these later circumstances, contingency plans may need to be adopted quickly to take into account the requirements of the shore

authorities. However, the basic considerations in these circumstances are still of the same nature as those when the ship is at sea.

When the ship is berthed alongside a cargo terminal, the responsibilities for action in the event of an accident are more complex, as the terminal management must also be involved both in the protection of the terminal facilities and in the provision of any remedial action. In the sense of that, Company has included exchanging of necessary information in preparation check lists for loading/unloading the cargo, which must be agreed and fulfilled with the terminal before any operation.

Officers Responsibility

- Chief Officer shall take charge of the Shipboard Emergency Team for deck related incident and keep the Master informed. He shall ascertain cause and, if possible, rectify the incident.
- Watch Officer, if the Chief Officer is otherwise engaged, shall take charge of the Team, initially supply any materials needed and keep the Master informed.
- Chief Engineer shall take charge of the Shipboard Emergency Team for an engine room related incident. He shall further ascertain cause of incident and, if possible, rectify it and keep the Master informed.
- First Engineer shall, if the Chief Engineer is otherwise engaged, take charge of the Team.
- Watch Engineer shall supply any materials needed and keep the master informed

Familiarization

The personnel to be involved must be familiar with the procedures of this manual and understand what may be required of them. The following personnel shall review this manual and fully familiarize themselves with the actions and responsibilities required:

- All office personnel and managers directly involved with vessels operations (Department Managers, Section Managers, Superintendents)
- Masters, Chief Engineers and Officers on Company vessels • Personnel listed in Emergency Team
- All other individuals who may become involved in the procedures outlined herein

2.2 Composition and allocation of personnel to fire parties.

An office based Emergency Team has been organized in order to deal promptly and effectively with casualties involving the Company vessels. The Team is formed from senior and experienced office staff members and will be activated to respond to casualties such as collision, fire, explosion, pollution or any other serious events affecting the ships and environment.

In principle, first contact should be established with contact person on emergency phone, who will be in charge to inform the Office Emergency Team.

The members of the Team are listed, with their contact numbers. That list must be placed on the bridge, in radio room, in engine control room, in cargo control room and conference room on all Company ships.

In case of a casualty, the Team will immediately be activated. Notification of an incident will normally come through operational channels from the Master, but first information will come through virtually any communication medium, by the quickest possible means.

The steps that must be taken as soon as the Company is notified are as follows:

- Assemble the Team (physically or by means of telecommunication)
- Define responsibilities
- Outline required facilities
- Define initial procedures for acquiring casualty information
- Asses the seriousness of the event
- Develop remedial procedures
- Communicate details of the event to the authorities, insurance interests, charters and cargo interests, ship agent and media, as appropriate
- Arrange for technical and salvage assistance
- Make arrangements to record all actions and events in connection with the casualty

Assembly of the Team

The Team member will normally receive initial notification of any casualty. In that moment his responsibility is to immediately inform the Technical Director who is the Team leader and who will start the assembly of the Team and any other actions, including informing the Company top management. In case of Technical Director absence, all obligations are delegated to his deputy.

Emergency Team Activities Each casualty is different and unique, and has a different set of parameters. However, the following guidelines are intended to help

the early stages of the occurrences. Activities are not limited and may be extended or reduced, based of the nature of the casualty.

- Initial Briefing on assembly, the Team shall be given a thorough up-date by the Team leader. As soon as all available information has been collected, the Team will decide if and which other personnel or facilities should be alerted. Prompt advice will need to be given by the appropriate Team member to Underwriters, Charterers, Cargo Interests, Classification Society, Agent at the previously intended next port of call and in vicinity of the casualty. If salvage services are likely to be required, appropriate Salvers may need to be contacted, and if technical advice on ship construction may be needed, the Classification Society should be alerted.
- Assistance to Casualty, among the other actions, at the earliest possible stage, a decision will be made regarding to dispatch one or more office personnel to the scene of the casualty. While they are in transit, the Team will establish the best means of communication with the ship and most appropriate shore base in her vicinity. Team will also arrange their reception in order to facilitate immediate contribution to the control of the casualty. An early assessment of the circumstances will lead to an indication of the requirements for assistance. The Team shall be able to contact and will be aware off the facilities available from the major Salvers. If the use of such facilities is required and has not yet been contracted, the Team will develop proposals and will contract for such assistance. Similarly, if assistance for unloading the cargo may be required, the Team will investigate the availability of ships and equipment for this purpose.
- Families or Serving Personnel will quickly learn of the casualty from the media or other means and, naturally, will be concerned. Whether or not injuries to personnel are reported, a team member shall be assigned to

make the earliest possible arrangements for the continual presence in the Company office of appropriate staff to provide information when necessary, and to have available information for bona fide representatives calling on the telephone.

- Media and Public Relation, whether or not information regarding the existence of the casualty has reached the news media networks, the General Director or delegated General Management member shall develop a mechanism to handle press conferences and appropriate release of information to the media.

The safety of everyone onboard depends upon the ability of ship personnel to meet the unexpected and it is the Master's duty to ensure that the ship emergency organization is ready to cope with all likely contingencies. The ship personnel shall be fully aware of the actions to take in case of emergency, following Company established plans and instructions, and Master's orders.

2.3 Training of seafarers in fire-fighting

The International Convention on Standards of Training, Certification and Watchkeeping for Seafarers (STCW), requires that seafarers be provided with "familiarization training" and "basic safety training" which includes basic fire fighting, elementary first aid, personal survival techniques, and personal safety and social responsibility. This training is intended to ensure that seafarers are aware of the hazards of working on a vessel and can respond appropriately in an emergency.

According to STCW, The STCW 95 Code requires that you take this 5-day course of instruction. This course has to be renewed every 5 years, or under certain

conditions, you have to show that you have at least 1 year of service on board vessels of 200 grt or more within the last 5 years. The components generally includes a Fire Prevention and Fire Fighting (Basic Fire fighting) course of 2 days, a Personal Survival Techniques (PST) course of 1.5 days, a Personal Safety and Social Responsibility (PSSR) course of half a day, and, First Aid / CPR (Basic First Aid) course of 1 day.

Basic Safety Training or BST is the starting point for persons seeking employment in the maritime industry.

Basic Offshore Safety Induction and Emergency Training or BOSIET is designed for marine personnel intending to work on an offshore installation in the UK maritime sector and forms part of a Common Offshore Safety Induction process.

This training is part of the mandatory basic safety training for all seafarers with designated safety duties. It deals with the precautions needed to minimize the risk of fires, how fires are caused and how to extinguish them.

After joining a ship, every crew member must be given instructions on the emergency procedures in use and trained in the use of its fire appliances and its equipment.

2.4 Fire Control Plans

The Fire Control Plan is a mandatory requirement of SOLAS convention described in Regulation 15 of Chapter II. The fire control plan provides us information about fire station on each deck of the ship, on various bulkheads, and in spaces enclosed

by “A” class division, “B” class divisions. It also explains us the type of fire detection system and fire fighting systems available on ship.

Important things about Fire Control Plan

Fire alarms, appliances, escape route, Switches etc.

Fire control plan tells us about various fire alarm systems, sprinkler installation, extinguishing appliances, means of escape to different compartments and decks, and ventilation system including particulars of remote operation of dampers and fans. The position of various dampers, their marking, and which fan is for particular compartment or deck is also explained so that required damper and fans can be closed in case of fire.

Graphic Symbol

The graphical symbols used in the fire control plan should be as per fighting equipment symbols set out in IMO Assembly Resolution A.654(16). It is duty of each and every member of ship’s crew to know the meaning of the symbols used in this plan.

Language

The fire plan should be available in the working language of the crew on board and also in English.

Location and Availability

The general arrangement plan should be permanently exhibited for the guidance of ship officer in conspicuous locations such as navigating bridge, engine room and accommodation.

At least one copy of the fire control plan shall be available ashore at the offices of the Company.

Copies of the fire control plan must be provided to each of the members of the fire patrol team in a passenger ship and also posted at each continuously manned central control station.

A copy of Fire Control Plan should be permanently stored in prominently marked weathertight enclosures outside deckhouse for assistance of shore side fire fighting system in case the ship is in port or in dry dock.

Also with the permission of Administration i.e classification society, the details can be set out in the form of booklet and a copy of it shall be supplied to each officer onboard. One copy of the same should be available on board and be easily accessible. These plans should be kept up-to-date and if alterations are made shall be recorded as soon as possible. The fire plan should be available in the working language of the crew on board and also in English language.

Renewal, update of Fire control plan

It comes under the responsibility of the master, ship owner and ship management team at shore to ensure that the fire control plan is kept up to date and if alterations are made shall be recorded as soon as possible.

Following are the cases when renewal or update in the fire control plan is required:

- Change in the fire fighting system, alarm system, escape route design or anything related to current fire plan takes place. The new system or design must be included and approval should be taken from the classification society

- Modification In ship structure or ship particulars which effect the current fire plan must be added to the new plan with approval of the classification society
- In case of revision of statutes related to fire control plan under SOLAS done by IMO or similar authority, the new fire plan to be provided and the fire fighting system or equipment must be as per the new revised plan
- When change of flag in a ship happens, the assigned classification society must review the ship fire control plan
- During the change of classification society, the fire control plan must be reviewed

Survey Requirement

The Classification society surveyor must ensure that there shall are discrepancies between the content of the fire control and the record of approved cargo ship (or passenger ship) safety equipment carried on board. In addition, the various entries in the record should correspond to the particulars of the equipment carried on board and with the associated service and maintenance reports and records.

Following surveys are required

Initial Survey: This is the survey to be done for issuing the approved fire control plan to the newly built ship.

Annual Survey: The fire control plan survey comes under the continuous ship safety equipment survey (CSSE) which is performed annually.

Renewal Survey: If the CSSE certificate is under renewal period requiring a survey, the fire control plan will require this survey.

The attending surveyor is required and expected to make a specific and explicit statement in the report of the relevant survey as to whether he has examined and has verified that the content of fire control plan found on board are in a readable state, updated, approved (or examined for compliance) and in accordance with the requirements of Regulations under SOLAS.

Importance of Fire control Plan

- The Fire control plan is not just a paper requirement for the classification society or the port state control. It is a useful document to understand:
- The location of various firefighting and safety equipment onboard for new joiners
- Location of nearest and safest fire-fighting equipment and escape route when fighting fire on ship
- The port fire fighting station team has no clue about the ship arrangement. The fire control plan is extremely useful and easy to read document to tackle major fire on ship by port Fire fighters
- Fire control plan is an important part of safety management plan of the ship and any discrepancy may lead to non-conformities against the SMS
- Copy of Fire control plans kept the shore officer is also inspected while issuing/ re-issuing the document of compliance (DOC) and safety management certificate (SMC) to the company

Expert Tip:

It is advisable for the master or the ship management team to provide a Fire control plan to the Fire Fighting station of the port authority of that Port where the ship is regular for cargo exchange.

2.5 Organization of fire and abandon ship drills

Legislation fire drills

According to SOLAS chapter III/19.3 every crewmember with assigned emergency duties shall be familiar with these duties prior to departure of the vessel. Drills shall, as far as practicable, be conducted as if there were an actual emergency. Every crew member shall participate in at least one abandon ship drill and one fire drill every month. The drills of the crew shall take place within 24 hours of the vessels departure from port if more than 25% of the crew have not participated in an abandon ship and fire drills on board of the particular vessel in the previous month (International Maritime Organization, 2004). Chapter 7.41.6 of the Maritime Regulations Republic of the Marshall Islands refers to the legislation of SOLAS; "The Master of each vessel shall cause the crew to be exercised at fire drills according to SOLAS Ch. III/19.3.4 at least monthly to satisfy the requirements of SOLAS Ch. III/19.3, or within 24 hours of the vessel leaving port if more than 25% of the crew have not participated in fire and abandon ship drills on board that particularly vessel the previous month" (Office of the Maritime Administrator, 2013).

According to SOLAS chapter III/19.2 on a vessel engaged in a voyage where passengers are scheduled to be on board for more than 24 hours, mustering of the passengers shall take place within 24 hours after their embarkation. Passengers shall be instructed in the donning of lifejackets and the actions to take in an emergency. Whenever new passengers embark, a passenger safety briefing shall be given immediately before departure, or immediately after departure. The briefing shall be made by means of an announcement, in one or more languages likely to be understood by the passengers. The announcement shall be made on the vessels public address system, or by other equivalent means likely to be heard at least by the passengers who have not yet heard it during the voyage.

Information cards, posters or video programs displayed on vessels video displays may be used to supplement the briefing, but may not be used to replace the announcement. On passenger vessels, 11 an abandon ship drill and fire drill shall take place weekly. It is not mandatory for the entire crew to participate in every drill, but each crew member must participate in an abandon ship drill and a fire drill each month. Passengers shall be strongly encouraged to attend to these drills (International Maritime Organization, 2004).

Chapter 7.41.6 of the Maritime Regulations Republic of the Marshall Islands refers to the legislation of SOLAS; "For passenger vessels, the Master of each vessels shall cause the crew to be exercised at fire and abandon ship drills at least weekly to satisfy the requirements of SOLAS Ch. III/30.2. The entire crew need not be involved in every drill, but each crew member must participate in at least one abandon ship and one fire drill each month as required by SOLAS Ch. III/19.3.2." (Office of the Maritime Administrator, 2013). According SOLAS chapter III/19.4 fire drills should be planned in such a way that due consideration is given to regular practice in the various emergencies that may occur depending on the type of vessel and the cargo. Each fire drill shall include (International Maritime Organization, 2004):

- reporting to stations and preparing for the duties described in the muster list required by regulation 8;
- starting of a fire pump, using at least the two required jets of water to show that the system is in proper working order;
- checking of fireman's outfit and other personal rescue equipment;
- checking of relevant communication equipment;
- checking the operation of watertight doors, fire doors, fire dampers and main inlets and outlets of ventilation systems in the drill area; and

- checking the necessary arrangements for subsequent abandoning of the vessel.

Chapter 7.41.6 of the Maritime Regulations Republic of the Marshall Islands refers to the legislation of SOLAS. Drills, to be extent practicable, shall be conducted as if an actual emergency existed, and at least contain the following points (Office of the Maritime Administrator, 2013):

- All fire pumps shall be started and sufficient outlets opened to determine that the system is in proper working order.
- Persons assigned to the use of rescue and safety equipment shall demonstrate their proficiency in the use of such equipment.
- In accordance with SOLAS Ch. III/19.2.2 and 19.2.3, as amended, passengers scheduled to be on board for more than 24 hours shall be mustered at their stations within 24 hours after their embarkation and instructed in the use of life preservers and the action to take in an emergency. The crew shall be instructed in crowd control duties.
- In addition to the requirements of SOLAS Ch. III/19.4, at the discretion of the Master, the crew may receive additional on-board training sessions or presentations related to lifesaving and firefighting measures, as appropriate.
- Mustering is required for newly embarked passengers who will stay more than 24 hours aboard passenger vessels. Mustering at the beginning or during the voyage shall be conducted prior to or immediately upon departure from any port at which an embarkation takes place. Whenever new passengers embark, a passenger safety briefing, which may be included in the muster, shall be given prior to or immediately upon departure.

The equipment used during drills shall immediately be brought back to its fully operational condition and any faults and defects discovered during the drills shall be remedied as soon as possible.

2.6 Strategies and tactics for control of fires in various parts of the ship.

Fire is a constant hazard at sea. It results in more total losses of ships than any other form of casualty. Almost all fires are the result of negligence or carelessness.

Fighting a fire on board ship may amount to a life or death struggle; to enter into such a conflict unprepared and unarmed is to invite failure. The 'armaments' or equipment available have been described. Now comes the matter of being prepared.

A basic strategy should be followed in all fire fighting situations. This will involve four distinct aspects, which are locating, informing, containing and finally extinguishing a fire.

A fire may be located by detection devices fitted in the various spaces in a ship or simply by smelling or seeing smoke. Alert personnel, whether on watch or not, should always be conscious of the danger of fire and the signs which indicate it.

Certain areas are more liable to outbreaks of fire and these should be regularly visited or checked upon. Once detected the presence of a fire must be made known quickly to as many people as possible. It is essential therefore that the bridge is informed of the location and extent of the fire. A small fire might reasonably be immediately tackled by the finder but attempts should be made

whilst fighting the fire to attract attention. Shouting 'Fire', banging on bulkheads, deliberately setting off equipment alarms in the vicinity, all are possible means of attracting attention. Anyone finding a fire must decide whether to fight it immediately or whether to leave it and inform others first. The more people who know of a fire the greater the efforts that can be brought to bear upon it. If in doubt—inform! Ships are built to contain fires in the space where they begin.

Fire resisting bulkheads and decks are positioned at appropriate distances in order to limit the spread of fire, and it remains for fire fighting personnel to ensure that these barriers are secure whilst attempting to fight the fire. All doors and openings should be closed, all ventilation and exhaust fans stopped, and flammable material isolated from the space. It should be remembered that a fire exists in three dimensions and therefore has six sides, so it must be contained on six sides. A small fire can usually be easily extinguished but it can also quickly become a big fire, so the fire extinguishing must be rapid if it is to be effective. Fire fighting strategy will vary according to the location of the fire. The various areas and their particular problems will now be examined.

Accommodation

The accommodation areas will be made up almost exclusively of Class A material requiring the use of water or soda-acid type extinguishers. Electrical circuits however should be isolated before directing quantities of water into an accommodation area. AH ventilation and exhaust fans must be stopped and fire flaps closed. If hoses are employed a water spray should be used in order to achieve the maximum cooling effect. The accommodation will no doubt fill with smoke and therefore breathing apparatus should be available.

The galley area presents a somewhat different fire hazard. Here Class B materials, such as cooking oil, fat or grease, will be present requiring the use of foam, dry powder or carbon dioxide extinguishers. A fire blanket quickly spread over burning cooking utensils could extinguish a potentially dangerous fire.

Machinery spaces

Machinery space fires will involve mainly Class B material requiring the use of foam type extinguishers. Only the smallest of fires should be tackled with hand extinguishers. The alarm should be quickly given and the bridge informed. The ventilation fans should be stopped and fire flaps closed. Any oil tanks close to the fire should be closed off and kept cool by hosing with water.

Foam-making equipment should be used on the fire and foam spread over the tank tops and bilges. Water spray can also be used to cool the surroundings of the fire, but a water jet should not be used in the machinery space since it will move any burning oil around and subsequently spread the fire. Only if the situation becomes hopeless should the space be evacuated and gas flooding used. The machinery space contains most of the fire fighting equipment as well as the propulsion machinery. If it is vacated then control of the situation is lost to a 'one-shot' attempt at gas flooding.

If evacuation is decided upon all personnel must be made aware of the decision. The space must then be completely sealed against the entry or exit of air and all oil supplies isolated at the tank valves. When all these matters have been attended to, the flooding gas can be admitted and, if the surrounding bulkheads hold to contain the fire, it will quickly go out. Cooling of the boundary bulkheads should continue from outside the space whilst flooding is taking place.

When the extinguished fire has been left long enough to cool down the space can be re-entered. This should be done from the tunnel, if there is one, or the lowest point remote from the seat of the fire. Engineers wearing breathing apparatus may now enter, taking water spray hoses with them to cool down any hot surfaces. Cooling and smoke dispersal are the first priorities to provide an atmosphere in which others can operate and gradually bring the machinery back into service. Where a machinery space fire involves electrical equipment then only dry powder or carbon dioxide extinguishers can be used until the equipment is isolated.

Cargo spaces

Where a fire occurs in a cargo hold with a smoke detection and carbon dioxide flooding system fitted, the procedure is straightforward and has already been described. It is essential to ensure before flooding that all air entry and exit points are closed by fire dampers and all fans are stopped.

Oil tankers with their cargo tanks full or empty present a potentially serious fire hazard, A fire occurring in a cargo tank will doubtless lead to an explosion or an explosion will lead to fire. The rapid use of foam making equipment, the cooling of surrounding areas and the isolation of the fire should immediately take place.

The prevention of fire and explosion conditions is the main prerequisite with oil tankers. With reference to hydrocarbon vapours, such as those present in oil tanks, the diagram shown in Figure 13.15 should be considered. The relative proportions of hydrocarbon vapour and oxygen necessary for a fire or explosion are shown. By keeping the tank atmosphere outside of the flammable limits, no fire or explosion can occur. It is usual practice to inert the tank atmosphere by

displacing the oxygen with an inert gas and thus effectively prevent a fire or explosion. The inert gas producing systems have already been described.

Training and awareness

Where is the nearest fire extinguisher? What type is it? How is it operated? At any position in the ship these questions should be asked and answered. Knowing how to operate any extinguisher just by looking at it will indicate some degree of training and an awareness of the fire defences.

Fire drills are often referred to as 'Board of Trade Sports', but they merit a more sober attitude than they receive. Practices are useful and should be seriously undertaken. Equipment should be tried and tested to ensure that it works and is ready when needed. Regular maintenance should take place on extinguishers, fire pumps, hydrants, hoses, etc. All engineers should be familiar with recharging and overhauling extinguishers and those in charge should make sure it is regularly done. The statutory surveys do much to ensure that equipment is ready for use but the one year period between leaves a lot of time for neglect.

Fire training manual (SOLAS vessels only)

A requirement of SOLAS is that a fire training manual is available onboard. The purpose of this manual is to provide those onboard with instructions relating to the use of fire fighting equipment carried by the vessel. It can also be used as a framework and reference guide to assist personnel in training others onboard. The manual is to be clearly written in a language and style easily understood by all of the crew along with illustrations and diagrams. The training manual must be ship-specific and shall explain as a minimum the following in detail.

- General fire safety practice and precautions related to the dangers of smoking, electrical hazards, flammable liquids and similar common shipboard hazards;
- General instructions on fire-fighting activities and fire-fighting procedures including procedures for notification of a fire and use of manually operated call points;
- Meanings of the ship's alarms;
- Operation and use of fire-fighting systems and appliances;
- Operation and use of fire doors;
- Operation and use of fire and smoke dampers; and
- Escape systems and appliances.

Two copies of this manual will be supplied to be placed in the crew and officers' mess rooms for any member of the ship's compliment to view. When any new equipment is supplied to the vessel, the Safety Officer must update these Training Manuals and carry out familiarization of the crew as part of the management of change process.

3. Inspect and service fire-detection and fire-extinguishing systems and equipment

3.1 Fire alarms

An emergency does not come with an alarm but an alarm can definitely help us to tackle an emergency or to avoid an emergency situation efficiently and in the right way. Alarm systems are installed all over the ship's systems and machinery to notify the crew on board about the dangerous situation that can arise on the ship.

Alarm on board ships are audible as well as visual to ensure that a person can at least listen to the audible alarm when working in an area where seeing a visual alarm is not possible and vice versa.

It is a normal practice in the international maritime industry to have alarm signal for a particular warning similar in all the ships, no matter in which seas they are sailing or to which company they belongs to. This commonness clearly helps the seafarer to know and understand the type of warning or emergency well and help to tackle the situation faster.

The main alarms that are installed in the ship to give audio-visual warnings are as follows:

- **General Alarm**: The general alarm on the ship is recognized by 7 short ringing of bell followed by a long ring or 7 short blasts on the ship's horn followed by one long blast. The general alarm is sounded to make aware the crew on board that an emergency has occurred.
- **Fire Alarm**: A fire alarm is sounded as continuous ringing of ship's electrical bell or continuous sounding of ship's horn.
- **Man Overboard Alarm**: When a man falls overboard, the ship internal alarm bell sounds 3 long rings and ship whistle will blow 3 long blasts to notify the crew on board and the other ships in nearby vicinity.
- **Navigational Alarm**: In the navigation bridge, most of the navigational equipments and navigation lights are fitted with failure alarm. If any of these malfunctions, an alarm will be sounded in an alarm panel displaying which system is malfunctioning.
- **Machinery space Alarm**: The machinery in the engine room has various safety devices and alarms fitted for safe operation. If any one of these

malfunctions, a common engine room alarm is operated and the problem can be seen in the engine control room control panel which will display the alarm.

- **Machinery Space CO_2 Alarm**: The machinery space is fitted with CO_2 fixed with fire extinguishing system whose audible and visual alarm is entirely different from machinery space alarm and other alarm for easy reorganization.
- **Cargo Space CO_2 Alarm**: The cargo spaces of the ship are also fitted with fixed fire fighting system which has a different alarm when operated.
- **Abandon Ship Alarm**: When the emergency situation on board ship goes out of hands and ship is no longer safe for crew on board ship. The master of the ship can give a verbal Abandon ship order, but this alarm is never given in ship's bell or whistle. The general alarm is sounded and everybody comes to the emergency muster station where the master or his substitute (chief Officer) gives a verbal order to abandon ship.
- **Ship Security Alarm System**: Most of the ocean going vessels are fitted with security alert alarm system, which is a silent alarm system sounded in a pirate attack emergency. This signal is connected with different coastal authorities all over the world via a global satellite system to inform about the piracy.

Different Alarm signals of the vessel are clearly described in the muster list along with the action to be carried out so that all the crew member can perform their duties within no time in actual emergency.

3.2 Fire detection equipment

Smoke and fire detection equipment is an integral part of any building's safety. When working properly, they alert the occupants in a building of a fire before it spreads, giving them enough time to evacuate. This type of equipment comes in many forms: heat detectors, smoke detectors, flame detectors, and CO gas detectors.

Heat Detectors

Unlike other types of alarm systems, heat detectors are not early warning devices. These devices are typically found in spots with fixed temperature, including heater closets, small rooms, and kitchen facilities. They should not be installed in areas with fluctuating ambient temperature. This is because the alarm on heat detectors is set to go off if there is a rise in the temperature.

Like their name suggests, these detectors are used to detect flames. When working properly, they detect fire nearly at the point of ignition. They are very useful for buildings involving with hazardous processes, as well as gas and oil refineries and manufacturing industries.

There are three subcategories of flame detectors: optical, UV, and IR.

- Optical detectors: The most commonly used, these feature optical sensors for detecting flames.
- UV detectors: These work very quickly. They can detect open flames, explosions, and fires within four milliseconds, due to the UV radiation emitted at the instant of ignition. However, to prevent accidental triggers, some UV detectors are designed to integrate a three second time delay.
- IR detectors:Infrared detectors monitor the head radiation that is generated by open flames and fire. They have a response time of three to five seconds. Accidental triggers can be caused by nearby hot surfaces and background thermal radiation. False alarms can be decreased with the use of special programming algorithms which are designed to recognize the frequency of flame flickering.

Smoke alarms are designed to detect fires quickly. Like flame detectors, this fire detection equipment is divided into three subcategories.

- Photoelectric alarms: These operate with the use of a light source, photoelectric sensor, and beam collimating system. When smoke begins to enter the optical chamber, it crosses the light beam path. This results in light being scattered by the particles in the smoke. The scattered light is then directed to the sensor, after which the alarm is activated and sounded.
- Ionization alarms: A small amount of radioactive material, which passes through the ionization chamber, is contained inside of these alarms. There are two electrodes inside the chamber, with empty space in between. The radiation permits a small current between the two electrodes. If smoke enters the chamber, it absorbs the alpha particles, which results in an

interrupted current and ionization reduction. When this occurs, the alarm is set off.

- **Combination alarms:** These have the features of both ionization and photoelectric alarm technologies. The photoelectric function responds to low energy smoldering fires, and the ionization function responds to rapid, high-energy fires.

If you're unsure which type of fire detection equipment to get, have a professional come in to assess your building to determine your requirements. Regardless of which alarm/detection device selected, you should have them professionally installed, and follow all instructions for testing and maintenance.

3.3 Fixed fire-extinguishing equipment

Fixed fire extinguishing installations

A variety of different fixed fire fighting installations exist, some of which are specifically designed for certain types of ship. A selection of the more general installations will now be outlined.

1. Fire main system for cargo ships

   An outbreak of fire requires a source of ignition, the presence of combustible material and ample oxygen. Of the three factors, oxygen is provided in large quantities in machinery spaces, accommodation, dry cargo holds and tanker pumprooms by ventilation fans. Air supply trunkings are not only a source for a supply of oxygen to feed the fire but also have potential for carrying smoke from one area to another.

2. Automatic water spray & water mist system for machinery protected area

   The automatic spray or sprinker system provides a network of sprinkler heads throughout the protected spaces. This system may be used in

accommodation areas, and in machinery spaces with certain variations in the equipment used and the method of operation.

3. Automatic foam induction system for machinery space fire

   Foam spreading systems are designed to suit the particular ship's requirements with regard to quantity of foam, areas to be protected, etc. Mechanical foam is the usual substance used, being produced by mixing foam making liquid with large quantities of water. Violent agitation of the mixture in air creates air bubbles in the foam.

4. CO2 fire extinguishing installations for machinery spaces

   Fire extinguishing installations employing CO 2 stored under pressure at ambient temperature are extensively used to protect ships' cargo compartments, boiler rooms and machinery spaces. When released the CO 2 is distributed throughout the compartment, so diminishing the relative oxygen content and rendering the atmosphere inert.

5. Inert gas systems, inert gas generator

   Inert gases are those which do not support combustion and are largely nitrogen and carbon dioxide. Large quantities suitable for fire extinguishing can be obtained by burning fuel in carefully measured amounts or by cleaning the exhaust gases from a boiler.

6. Fire fighting Halon system

   A Halon storage system would be very similar to one using carbon dioxide except that fewer cylinders would be required. The liquefied Halon is usually pressurised in the cylinders with nitrogen in order to increase the speed of discharge.

Other important fire & safety equipments

- Use of Breathing apparatus

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.

- Emergency Fire pump cargo ships machinery spaces

  Two independently powered pumps must be provided in all cargo ships of 1000 tons gross and over and in passenger ships of less than 4000 tons gross. Larger passenger vessels and passenger ferries must have three such pumps.

- Foam adapter for machinery space fire

  Foam branch pipes which operate in a similar manner to those used in deck installations for tankers, are fitted for use with the hydrants in some machinery spaces and in particular for passenger ferry car decks.

- Various fire detectors working principle

  The main function of a fire detector is to detect a fire as quickly as possible; it must also be reliable and require a minimum of attention.

- Fire detection system

  The fire detection system is to be classed as Critical Equipment and must be maintained in good working order.

- Fire fighting strategy for cargo ships

  A basic strategy should be followed in all fire fighting situations. This will involve four distinct aspects, which are locating, informing, containing and finally extinguishing a fire.

3.4 Fire main, hydrants, hoses, nozzles and pumps

Fire main

Whilst the various types of portable extinguishers form the front line of attack against a fire detected in its early stages, the fire main or one of the other fixed fire-fighting installations is used if a fire becomes established. The fire main extends to the full length of the ship and from the machinery spaces to the highest levels. Hydrants served by the main, are situated so that with suitable hoses any area on the ship can be reached.

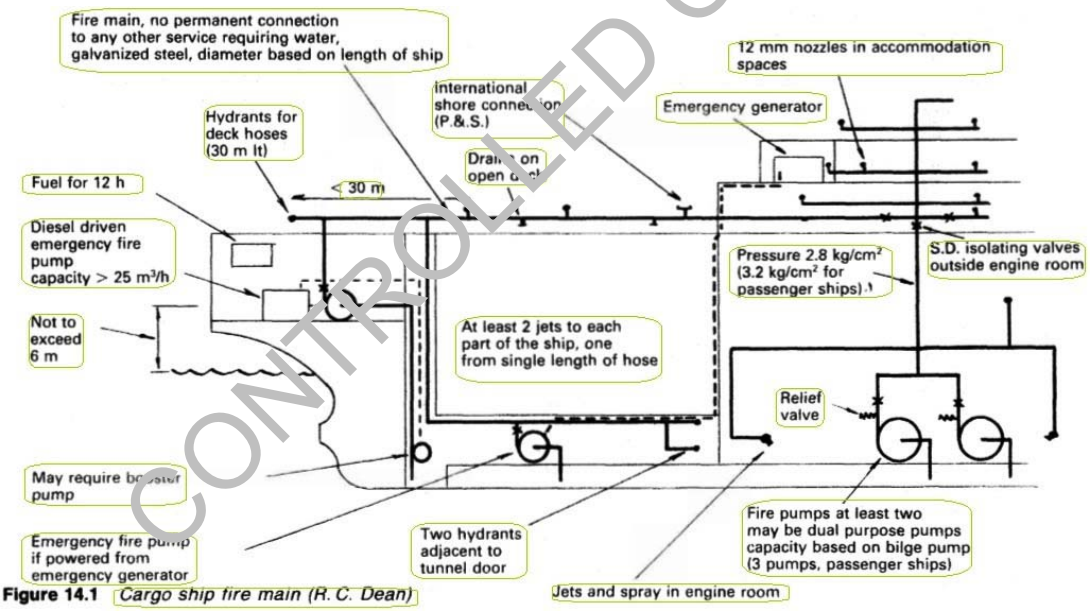


Figure 14.1 *Cargo ship fire main (R. C. Dean)*

Water is the chief fire fighting medium on a ship and the fire main is the basic installation for fighting fires. The system shown for the cargo ship (Figure 14.1) has two independently powered pumps which are also used for general service and ballast. These pumps supply engine room hydrants and the deck main through the screw down isolating valve which must be accessible from outside of the machinery space. The latter is required to prevent loss of water through damaged

pipework in the engine room if, to maintain the deck supply, the emergency fire pump has to be used. The emergency fire pump is shown as being situated in a tunnel, with a supply to the deck main through the tunnel escape and also to the twin hydrants in the shaft tunnel by the engine room watertight door.

The deck main has a drain at the lowest position so that the pipe can be emptied (particularly of fresh water) in cold weather. If this is not done, the pipe can be damaged by the water freezing but more importantly, it will be blocked by the ice and not usable.

It is a statutory requirement that a fire main and deck wash system should be supplied. This has hose outlets on the various decks, and is supplied by power driven pumps in the machinery spaces. Provision may be made for washing down the anchor chain from a connection to the fire main.

Fire Hoses

A fire hose (or firehose) is a high-pressure hose that carries water or other fire retardant (such as foam) to a fire to extinguish it. Outdoors, it attaches either to a fire engine or a fire hydrant. Indoors, it can permanently attach to a building's standpipe or plumbing system.

The usual working pressure of a firehose can vary between 8 and 20 bar (800 and 2,000 kPa; 116 and 290 psi) while per the NFPA 1961 Fire Hose Standard, its bursting pressure is in excess of 110 bar, (11,000kPa; 1600psi)[1]

After use, a fire hose is usually hung to dry, because standing water that remains in a hose for a long time can deteriorate the material and render it unreliable or

unusable. Therefore, the typical fire station often has a high structure to accommodate the length of a hose for such preventative maintenance.

On occasion, fire hoses are used for crowd control (see also water cannon), including most notably by Bull Connor in the Birmingham campaign against protestors during the Civil Rights Movement in 1963.

Fire Hydrant

A fire hydrant, also called a fireplug, fire pump, johnny pump, or simply pump, is a connection point by which firefighters can tap into a water supply. It is a component of active fire protection.

Fire Nozzles

A fog nozzle is a firefighting hose spray nozzle that breaks its stream into small droplets. By doing so, its stream achieves a greater surface area, and thus a greater rate of heat absorption, which, when compared to that of a smoothbore nozzle, speeds its transformation into the steam that smothers the fire by displacing its oxygen. Specially designed fog nozzles (with no stream adjustment) have been certified by Underwriters Laboratories (UL) for use on Class B & C hazards.

Fog nozzles play an important part in firefighting tactics due to their versatility. The wide variety of fog nozzle manufacturers allows them to accommodate different sizes of fire hose- most often attack hand line- and streams and are capable in both fire protection and attack. With regard to flow rate, it is imperative to be sure that each fog nozzle be able to handle the flow rate of its water supply because the master stream devices to which they are sometimes attached can expel up to 2,000 US gallons (7.6 m3) per minute. Nevertheless, as with almost all fog nozzles, those on master stream devices come with either automatic or manual spray pattern and stream adjustments. However one significant disadvantage of fog nozzles is that Compressed Air Foam (CAF) bubbles' ratio of surface area to volume (which are formed by mixing air into a solution of water and foaming agents at the pump) exceeds that of fog nozzles' water droplets; therefore, the mechanical deflection in the nozzles themselves causes a loss of bubble structure, thereby reducing the CAF's ability to absorb heat. Despite this drawback, provided an appropriate nozzle pressure and water supply, fog nozzles are effective for any ground fire situation.

3.5 Portable and mobile fire extinguishing equipment including appliances

Various fire extinguishing appliances are available, including, though not limited to the following types of appliances:

- **Hand-held fire extinguishers**

  A hand-held fire extinguisher is a portable appliance which is suited to handling by a normal person of average physical strength. Such a fire extinguisher usually ranges from a total mass of as little as 1kg to about 23kg. A fire extinguisher of this nature must be considered as ‘first-aid’ fire-fighting equipment due to the limited duration of discharge of such

equipment. A portable fire extinguisher consists of a metal cylinder which is surmounted by a handle and a discharge lever.

Most fire extinguishers come with brackets for mounting against a solid surface, such as a wall or the inside of a car. The larger units come mounted on a trolley. By removing the safety pin and pressing the discharge lever, the fire extinguishing agent, called the 'charge', is released. Hand-held fire extinguishers include the basic types of fire extinguishers. Keep in mind that you can put yourself in danger, or even increase the intensity of a fire, if you use the incorrect type of extinguisher on it.

- **Water extinguishers**

  Water extinguishers have better cooling properties than other fire extinguishers and can readily penetrate to reach a deep-seated fire. A deep-seated fire is a fire which usually burns far below the surface in a duff, mulch, peat or other combustible as contrasted with a surface fire. Water extinguishers are identifiable by their red instruction label, and are

considered effective for dealing with Class A fires, as they cool down a fire. Do NOT use them on electrical equipment.

To use a water extinguisher, follow the PASS steps in the following order:

- Remove the safety pin (Pull).
- Direct the jet of water at the base of the flames (Aim).
- Squeeze the trigger of the discharge lever (Squeeze).
- Keep moving the jet across the area in a sweeping motion (Sweep).
- Only try to combat small, minor fires.

The disadvantage in using a water extinguisher is that it can cause some fires, such as a petrol fire, to spread rapidly. The water that is used in such extinguishers is also a ready conductor of electricity, and can be extremely dangerous in the case of Class C fires, where there is a live electric current present.

- **Foam extinguishers**

Foam extinguishers are well suited for use on small Class B fires to combat the spreading of burning liquid. Such fire extinguishers can be identified by the cream-coloured label that they bear, and should be used on fires involving flammable liquids, such as grease, gasoline and oil.

The foam serves to cool the fire down, to prevent the release of vapour from the fire, to prevent reigniting of the fire, and to smother the fire. Such extinguishers are not suitable for use on flowing flammable liquid spillages. Care must be taken with their use, as the foam that they use conducts electricity. To use a foam extinguisher, follow the instructions that are given under water extinguishers above.

The disadvantage in using a foam extinguisher is that it contains foam, which is a ready conductor of electricity. Its use can, therefore, be hazardous in the case of Class C fires, when there is an electric current present.

- **CO2 extinguishers**

CO2 extinguishers are well suited for use on small Class B fires, as well as on Class C fires, since CO2 is a non-conductor of electricity. Such extinguishers can be identified by means of the black instruction label that they bear. They are considered best suited for fighting those fires which involve electrical equipment, but also effectively cope with flammable liquids, so that they are the best type of fire extinguisher to use on Class BC fires.

Such extinguishers deliver a high concentration of CO2 gas under pressure, producing inert vapour, which excludes oxygen and smothers the fire. To use a CO2 extinguisher, follow the instructions that are given under water extinguishers above.

CO2 extinguishers have limited cooling properties; hence, they provide no protection against reignition and are, consequently, considered to be ineffective in outdoor applications.

- **Dry chemical powder extinguishers**

Dry chemical extinguishers are very effective for quelling Class B fires, as they can readily halt the spread of burning liquid. Dry chemical powder extinguishers are identifiable by their blue instruction label, and are best suited to combating larger flammable liquid fires (Class A), though they can also be used on electrical fires (Class C).

They are often referred to as ABC dry powder extinguishers, due to their capacity to quell Class A, B and C fires. The extinguisher is filled with powder (mono-ammonium phosphate), which is kept under nitrogen pressure. Powder is expelled from the extinguisher by means of the exertion of gas pressure, and is very effective as a knockdown agent for flammable liquid fires. To use, follow the instructions given under water extinguishers above.

Keep in mind that the powder has no cooling properties, so that it does not prevent the reigniting of Class B fires. The dry chemical powder, which is messy, can damage electrical equipment, such as engines.

- **Vaporising liquid extinguishers / Argonite extinguishers**

  Argonite extinguishers are identifiable by means of their green instruction label. They are best suited for use on flammable liquid (Class A) fires and on electrical (Class C) fires. Such extinguishers contain a blend of argon and nitrogen, which is stored in the fire extinguisher under the pressure of nitrogen. When the blend is expelled, it is vaporised by the heat of the fire, producing a smothering effect, by means of reducing the oxygen content. The vaporised liquid also interacts with the chemical combustion that takes place, which helps to extinguish the fire. To use a vaporising liquid or aragonite extinguisher, follow the instructions given under water extinguishers above.

- **Fire hose reels**

  The fire hose reel is also, by definition, considered to be a portable fire-fighting appliance, due to its extended hose feature. Such reels are often available in a swing-type design, which offers an all-directional flexibility, or

which else comes in a static installation. Since the fire hose reel uses water, it is only effective against Class A fires.

- **Fire blankets**

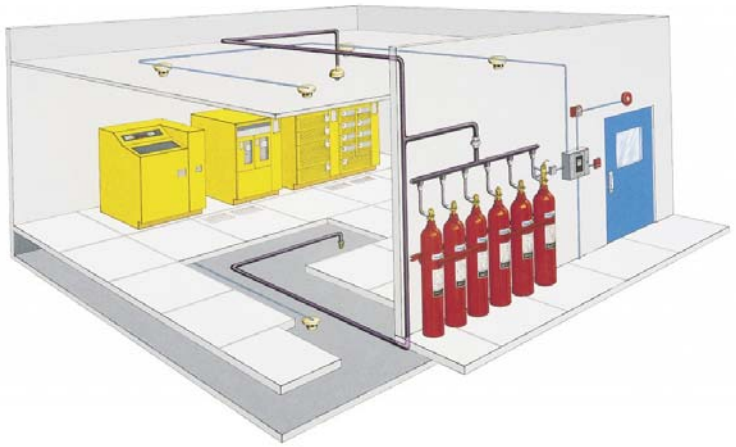
  Fire blankets are fire resistant, light and easy to handle. You can use them to extinguish a fire on a person whose clothing has caught on fire, by wrapping the blanket around the body of the person concerned. You can also use a fire blanket to cover a stove in the event of a pan fire, or even use one to cover yourself with in order that you might flee a building through its hot spots, if you have no other way out. Such blankets should be kept nearby any potential fire hazard.

- Fire buckets

  The water or sand in fire buckets can effectively be used to quell small Class A fires that are still in their early stages. However, they are considered to be unreliable as a method of fighting fires.

- Fire suppression systems

  In addition to the conventional fire extinguishers that are often seen in red containers, fire extinguishers also come in various other forms, such as in the form of suppression systems, which can vary from sprinklers, gas suppression, foam and CO2 systems to argonite and FM 200 (halon replacement) systems.



3.6 Firefighter's outfits and other personal protection equipment

Personal protective equipment (PPE) refers to protective clothing, helmets, goggles, or other garments or equipment designed to protect the wearer's body from injury or infection. The hazards addressed by protective equipment include physical, electrical, heat, chemicals, biohazards, and airborne particulate matter. Protective equipment may be worn for job-related occupational safety and health purposes, as well as for sports and other recreational activities. "Protective clothing" is applied to traditional categories of clothing, and "protective gear" applies to items such as pads, guards, shields, or masks, and others.

The purpose of personal protective equipment is to reduce employee exposure to hazards when engineering controls and administrative controls are not feasible or effective to reduce these risks to acceptable levels. PPE is needed when there are hazards present. PPE has the serious limitation that it does not eliminate the hazard at the source and may result in employees being exposed to the hazard if the equipment fails.

Any item of PPE imposes a barrier between the wearer/user and the working environment. This can create additional strains on the wearer; impair their ability to carry out their work and create significant levels of discomfort. Any of these can discourage wearers from using PPE correctly, therefore placing them at risk of injury, ill-health or, under extreme circumstances, death. Good ergonomic design can help to minimise these barriers and can therefore help to ensure safe and healthy working conditions through the correct use of PPE.

Practices of occupational safety and health can use hazard controls and interventions to mitigate workplace hazards, which pose a threat to the safety and

quality of life of workers. The hierarchy of hazard controls provides a policy framework which ranks the types of hazard controls in terms of absolute risk reduction. At the top of the hierarchy are elimination and substitution, which remove the hazard entirely or replace the hazard with a safer alternative. If elimination or substitution measures cannot apply, engineering controls and administrative controls, which seek to design safer mechanisms and coach safer human behavior, are implemented. Personal protective equipment ranks last on the hierarchy of controls, as the workers are regularly exposed to the hazard, with a barrier of protection. The hierarchy of controls is important in acknowledging that, while personal protective equipment has tremendous utility, it is not the desired mechanism of control in terms of worker safety.

3.7 Rescue and life support equipment

All ships must carry certain emergency and life-saving equipment. This equipment must meet minimum standards and must be properly tested and serviced.

There are different requirements depending on the size and type of ship and where it operates.

Emergency and life-saving equipment include things like:

- lifeboats and liferafts
- lifebuoys
- lifejackets and attachments
- buoyancy apparatus
- emergency alarm systems and public address systems
- marine evacuation systems
- two-way VHF radiotelephone sets

- fire-fighting equipment

3.8 Salvage equipment

Marine Salvage is the process of rescuing, repairing and refloating a ship, its cargo and crew and other properties from unforeseen imminent peril. Ship salvage operations are mandatory and must be accomplished rapidly and without delay in order to repair, remove ship wreck and clear out the passage for further navigation and also reduce marine pollution.

There are a few types of composite marine salvage processes. Let's have a glimpse at them.

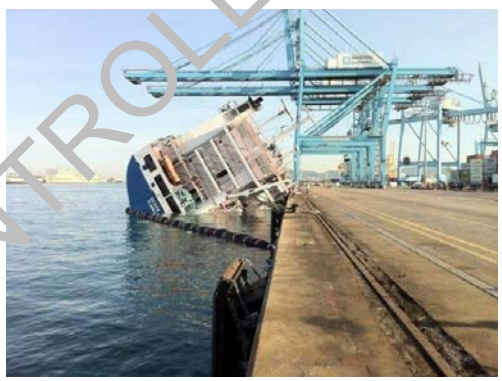
Offshore Salvage

These operations encompass stranded or sunken ships in open waters and are often too challenging as the ships would be exposed to sea waves and weather. The procedure may take months as the hostility of the nature could hinder the workflow with frequent intervals between work-shifts for the attributes of unusual tides or inclement weather.

Hurried and rapid accomplishment of the task is requisite for which, in addition to regular stable work force and salvage tugs and vessels, portable diving facilities should also be implemented at the work area transported by small boats or helicopter.

Harbour Salvage

This is not as much as same as the offshore salvage since being less challenging for the operations cover stranded or sunken ships in sheltered water and are unhindered by the natural conditions like intemperate weather or waves and currents. Unless it's too necessary to clear out the passage for navigation there is not much need to hasten the process.



Also harbour salvage is not much time consuming, hence the pace can be adjusted in accordance with the requirements of labour resources like man power and heavy equipments like cranes, construction tenders, dredges and barges.

Cargo Salvage

This is even more important, sometimes, than salvaging the ship itself, as the cargo onboard may pose an imminent threat to the marine environment. The

priority is to get rid of any hazardous element and save any expensive material as much as possible before it gets dumped in the water, beyond further repair.

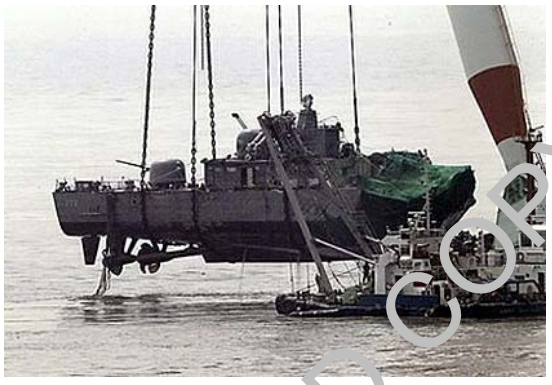
Equipment Salvage

Another focus is on salvaging large machinery components like engines, turbines, driving systems by dissecting, disassembling or destructing the hull if these equipments survive the intrusion of seawater.

Ship Wreck Salvage

This is a low priority task than the above mentioned salvage operations. The objective is to disembarrass the water area of hazardous or unsightly substances using the most practical and cheapest method possible. One of the most common

methods is to cut the hull into very small sections and refloat the parts and scuttle it in deeper waters.



Recognizing and correcting potential hazards and safeguarding the environment by removing them prior to the disposal of the wreck is indispensable in ship wreck salvage operations.

Afloat Salvage

When a ship is damaged but still floats in the water the salvage operation is called afloat salvage. This doesn't take a toll of challenging exertions as the work involve damage controlling and primary repairing tasks like the hull welding, stabilizing by rebalancing ballast tanks and shifting cargo and structural bracing.

The purpose and the path of the ship might get a little disrupted but it can remain underway with a timely afloat ship salvage operation.

Clearance salvage

These operations are carried out as the aftermath of catastrophic events like Hurricane, Tsunami, and War etc. In clearance salvage a number of ship wrecks are scavenged or removed co-ordinately to clear out the passage in a harbour or waterway that can be blocked for navigation by multiple obstructions with ships' varying degrees of damage due to events like fire, collision, or explosions etc.

3.9 Communication equipment

Radio telecommunication at sea had undergone a sea change in the last century. After the days of semaphores and flags (which is still relevant today in some cases), radio brought about a drastic change in marine communication at sea.

From the early years of the last century, ships started fitting radio for communicating distress signals among themselves and with the shore. Radio telegraphy using Morse code was used in the early part of the twentieth century for marine communication.

In the seventies, after considering the studies of the International Telecommunication Union, IMO brought about a system where ship-to-ship or ship-to-shore communication was put into action with some degree of automation, wherein a skilled radio officer keeping 24×7 watch was not required.

Marine communication between ships or with the shore was carried with the help of on board systems through shore stations and even satellites. While ship-to-ship communication was brought about by VHF radio, Digital Selective Calling (DSC) came up with digitally remote control commands to transmit or receive distress alert, urgent or safety calls, or routine priority messages. DSC controllers can now be integrated with the VHF radio as per SOLAS (Safety Of Life at Sea) convention.

Satellite services, as opposed to terrestrial communication systems, need the help of geo-stationary satellites for transmitting and receiving signals, where the range of shore stations cannot reach. These marine communication services are provided by INMARSAT (a commercial company) and COSPAS – SARSAT (a multi-national government funded agency).

While INMARSAT gives the scope of two way communications, the Corpas Sarsat has a system that is limited to reception of signals from emergency position and places with no facilities of two way marine communications, indicating radio beacons (EPIRB).

For international operational requirements, the Global Maritime Distress Safety System (GMDSS) has divided the world in four sub areas. These are four geographical divisions named as A1, A2, A3 and A4.

Different radio communication systems are required by the vessel to be carried on board ships, depending on the area of operation of that particular vessel.

All oceans are covered by HF marine communication services for which the IMO requires to have two coast stations per ocean region. Today almost all ships are fitted with satellite terminal for Ship Security Alerts System (SSAS) and for long range identification and tracking as per SOLAS requirements.

On distress, Search and Rescue operations from Maritime Rescue Co-ordination centers are carried out among other methods, with the help of most of these marine navigation tools. Naturally, the sea has become a lot safer with these gadgets and other important navigation tools recommended by the IMO and as enshrined in GMDSS.

3.10 Requirements for statutory and classification surveys.

Classification surveys are carried out by qualified surveyors using mainly visual inspection and sampling techniques. They do not consist of comprehensive verification or monitoring.

Classification certificates are issued for a 5-year period, subject to the satisfactory completion of periodical in-service surveys. The most common periodical classification surveys are the annual (for the vessels with additional service feature “annual survey”), intermediate and class renewal surveys. In accordance with BV Rules, it is owner’s responsibility to present the vessel for survey within the appropriate dates. Bureau Veritas publishes the vessel’s classification status showing the due dates of each periodical survey, both on-

line through VeriSTAR Info for owners that subscribe to this service, or by means of “ship status” sent to the owners by appropriate Connecting Districts.

In addition to the classification rules, vessels must comply with a number of Statutory Regulations. This compliance is to be primarily ensured by the Flag Administration of the country where the vessel is registered, which may delegate all or part of their powers to classification societies.
The principles of the statutory inspection and survey work are basically the same as in respect of classification surveys, that is the verification by Bureau Veritas qualified surveyors that a vessel is in compliance with applicable requirements at the time of the survey.

BUREAU VERITAS has been recognized by the Rhine Commission since the 1970s and is included on the UNECE (United Nations Economic Commission for Europe) list of classification societies recommended for recognition by contracting parties within the scope of the European ADN Agreement for the carriage of dangerous goods.

BUREAU VERITAS meets the criteria set out in European Directive 2006/87/EC and is authorized to carry out design reviews and surveys and to issue inspection reports, attestations of compliance or community certificates when empowered by flag state administrations to act on their behalf.

For maritime regulations, 130 flag state administrations recognize BUREAU VERITAS as an official certification body. Our experience shows that an holistic approach to the safety of vessels, with one organization assuming responsibility both for statutory and class requirements, reduces unnecessary interfaces that

may introduce points of weakness and possible breakdowns into the overall process.

For inland navigation vessels, and vessels operated in restricted maritime areas, BUREAU VERITAS already acts regularly on behalf of 13 countries, some others are subject to delegation on a case by case basis.

Today, the main statutory regulations where BUREAU VERITAS can provide services, totally or partially are the following:

- EUROPEAN DIRECTIVE 2006/87/EC AND 2008/68/EC
- RVBR, RHINE VESSELS INSPECTION REGULATIONS
- ADN, EUROPEAN AGREEMENT CONCERNING THE INTERNATIONAL CARRIAGE OF DANGEROUS GOODS
- BELGIAN ROYAL DECREE FOR ESTUARY NAVIGATION 8 MARCH 2007
- FRENCH DECREES (ARRÉTÉ "PORT 2000", DIVISION 229)
- RESOLUTION 61 - RECOMMENDATIONS ON HARMONIZED EUROPE-WIDE TECHNICAL REQUIREMENTS FOR INLAND NAVIGATION VESSELS
- DFND – GENERAL PROVISIONS ON NAVIGATION ON THE DANUBE
- NORMAM 02 – BRAZILIAN REGULATION FOR INLAND NAVIGATION VESSELS

4. Investigate and compile reports on incidents involving fire

4.1 Fire Investigation and reporting

Fire investigation involves the examination of all fire-related incidents once firefighters have extinguished the fire. The practice is similar to the examination of crime scenes in that the scene must be preserved and evidence collected and

analyzed, but with numerous additional difficulties and dangers. The investigation will include closely surveying the damaged scene to establish the origin of the fire and eventually establishing the cause.

However in order to effectively examine and evaluate a fire scene, it is imperative that the investigator has a detailed knowledge of the chemistry and behaviour of fire and its effects.

Nature & Chemistry of Fire

Fire occurs due to the exothermic reaction of combustion (burning), producing heat and light. In order for a fire to occur, three vital components must be present: a fuel source, an oxidant (O2) and a sufficient amount of energy in the form of heat. Together these make up the fire triangle. A fourth factor can also be described – a self-sustaining chemical chain reaction – to produce the fire tetrahedron. The absence of any of these conditions will result in a fire not starting or extinguishing through smothering (oxygen removal), cooling (heat removal) or starving (fuel removal).

Solid and liquid materials do not actually combust, but the process of heating causes them to produce vapours which can burn. This is the process of pyrolysis. Through this pyrolysis products will be formed, flammable and volatile substances of low molecular weight caused through the decomposition of materials by fire.

The colour of flames can vary depending on the materials involved in the combustion. The colour of a flame is basically determined by the wavelength of light emitted, which varies depending on the material. For example, red/yellow/orange flames are commonly encountered when carbon is present.

Inorganic substances can produce more obvious colour differences, such as copper which will cause a green flame.

Heat produced by a fire can spread in one of three ways; convection, conduction and radiation. Convection is the transfer of heat through air circulation, and only occurs in liquids and gases. An example of convection is the heat from a fire rising and heating the ceiling of a room. Conduction is the transfer of heat through a medium by direct contact, such as a fire heating a metal beam which transfers the heat elsewhere. Radiation is the emission of heat as infrared radiation without a medium, such as a fire heating and igniting a nearby sofa.

Ignition

Ignition will occur when all required conditions to start a fire occur, producing either a smouldering or flaming fire. This will often be induced by the addition of heat to a fuel in air, which can be caused by various sources such as exothermic chemical reactions, friction, solar radiation and electricity.

The temperature required for ignition to occur varies depending on the fuel. The flash point is the minimum temperature at which fuel favour is momentarily ignited in air by an external ignition source. However this will not necessarily sustain combustion and produce a fire. The flame or fire point is the minimum temperature at which enough vapour is produced to allow continued combustion. This is usually a few degrees higher than the flash point. Both the flash and flame point of a substance can be determined by placing a small amount of sample in an airtight container, gradually increasing its temperature whilst periodically adding an ignition source, and then measuring the point at which the flash and flame point is reached.

The spontaneous ignition temperature, also known as the auto-ignition point, is the lowest temperature at which a substance will ignite without any external ignition source. This is measured by heating a sample, studying the central temperature of the material and documenting the temperature at which ignition spontaneously occurs.

The flash point, flame point and spontaneous ignition temperature are the lowest temperatures at which a material has ignited when heated experimentally, though these actual temperatures can vary and so should only be used as a guideline. Different fuels also have individual lower and upper flammability limits, the lowest and highest concentrations of flammable gas required for combustion. If the concentration falls outside of this flammability range, combustion will not generally occur. Substances such as hydrogen have wide flammability ranges, making them particularly dangerous.

Smouldering

Not all types of fire produce flames. Smouldering is a form of flameless combustion which occurs at the surface of the material in cellulosic substances that can form a solid char. The presence of a smouldering fire is characterized by extremely localized burning and the production of thick, tarry smoke. The surface temperature can be linked to the colour of the smouldering. For example, dark red surfaces suggest a temperature of 500-600oC, whereas a white surface indicates temperatures in excess of 1400oC. The rate of propagation is dependent on the material burning and the amount of oxygen available. Only low concentrations of oxygen are required for smouldering combustion, but if sufficient oxygen is supplied, smouldering fires can then produce flames. Cigarettes are a common

cause of smouldering fires when left in contact with upholstered furniture, for example.

Spontaneous Combustion

Spontaneous combustion refers to the sudden ignition of a material without an external ignition source such as a flame or spark. The phenomenon occurs as a result of exothermic chemical reactions occurring within the material, releasing heat. In cases where the material is piled together, the heat cannot dissipate effectively and so the temperature within the material rises. The rise in temperature causes chemical reactions to accelerate, producing even more heat. The temperature can rise until the flame point of the material is reached, causing ignition. Spontaneous combustion tends to be characterised by the apparent source of the fire being the centre of the material, as heat is dissipated more readily from the surface, thus resulting in the centre reaching the highest temperature. Rags soaked with oil, sawdust or piles of hay have been known to spontaneously combust.

Fire Scene Investigation

The primary purposes of a fire investigation is to establish the origin (seat) of the fire, determine the likely cause, and thus conclude whether the incident was accidental, natural or deliberate. It is vital to establish the cause to ensure similar events do not occur (in the case of natural or accidental) or to allow a legal investigation to be conducted (in the case of deliberate fires).

Safety

The initial concern with regards to a fire incident scene is safety. Such a scene has an increased risk factor with possible hazards including heated materials, structural

collapse, damaged electricity and gas mains, debris, asbestos, dangerous combustion products and other toxic substances. A dynamic risk assessment should be conducted, the scene must be declared safe and all individuals entering the scene should wear appropriate protective clothing such as hardhats, fire-resistant overalls, steel-capped boots, thick gloves and, in some cases, a face mask. Supplies of gas and electricity should be switched off before the investigation begins.

Witnesses

Information regarding a fire can be obtained from witnesses. Witnesses may be able to provide details of the premises prior to the fire in addition to details of the fire itself, such as suspicious activity or apparent fire spread and smoke colour. Onlookers may even have taken photographs or video recordings of the incident on their mobile phones or cameras. The owner of the building/area may be able to detail the contents and layout of the building as well as any other potentially pertinent facts. However it should always be taken into consideration that civilian witnesses may be unreliable and could even have been involved in the fire incident. Emergency service personnel, such as police and fire fighters, are considerably more reliable as witnesses. Fire fighters in particular may be able to provide useful information on the possible origin of the fire and any unusual conditions. Fire fighters should also be interviewed to identify any disturbances made to the scene during fire-fighting efforts.

Ideally eyewitnesses should be interviewed by an objective individual with experience in interviewing in such a way that the information they provide is not influenced.

Scene Examination

A fire incident should be treated as a crime scene in that the area should be strictly controlled by a cordon to preserve evidence and allow access to authorised personnel only, with the scene and evidence being fully documented. A plan of the premises should be produced where possible to include the locations of objects, though it must be taken into consideration that disturbance may have been caused during fire-fighting efforts.

The investigation should ideally begin with an external examination of the scene. This allows for the identification of entry point, signs of forced entry, indications as to the origin and cause of the fire, artefacts and any possible safety concerns. All doors and windows should be examined to establish whether or not they were locked during the fire. Once again, fire-fighters may have forcefully entered the building or smashed windows to provide ventilation, and damage caused by the fire itself may appear similar to signs of forced entry. The external examination will also allow for the search for items relevant to the incident, such as tools used to break into the building, ladders or containers of flammable substances. It may also be important to note weather conditions, as temperature and wind conditions can affect a fire in terms of fire propagation and direction.

The interior examination of the scene is then conducted, usually with the production of the layout of the scene detailing the location of items and any bodies. The investigator will generally begin with the area of least damage, allowing investigators to backtrack to the seat of the fire, which will typically be found in a more damaged region.

Establishing the Origin

A vital aspect of the forensic fire investigation is to establish the point of origin of the fire, also known as the seat of fire. There are numerous indicators that can be used to determine the possible origin. The region in which a fire started will generally burn for a longer amount of time, thus will be an area with the worst damage. Fires tend to burn upwards, therefore the seat of the fire is likely to be found at a lower point of burn damage. However this is not always reliable as fires can spread downwards, particularly in the presence of certain fuel sources.

Fire effects on certain materials can indicate the direction of fire. As fire burns upwards and outwards, V-shaped smoke/burn patterns may be found on surfaces adjacent to the fire, with the end of the V pointing towards the point of ignition. However ventilation can affect the path or shape of V-shaped patterns. Smoke deposits of object surfaces can suggest the direction from which the fire originated, and glass and plastics tend to melt in the direction of fire, thus distortion of such materials can act as directional indicators.

Structural damage to the building can also be used to locate the seat of the fire. In some instances buildings may collapse in such a way that the area first weakened by the fire is clear, suggesting this is where fire damage first occurred and thus is the origin. Similarly, windows and ceiling structures are likely to fail in areas close to the seat of the fire first. However this is by no means an accurate method of locating the seat of the fire, as the collapse and damage of a building is affected by numerous factors, not just the fire itself.

It may be possible to determine the area in which a fire began based on the operation of smoke and fire alarms. There may be some form of record of which

alarm was triggered first, suggesting the fire is likely to have started in that room. The order in which alarms were triggered can be used further to establish the path of propagation of the fire. However such information is not available for all premises.

The investigator may be required to excavate the scene and systematically remove debris in order to identify the possible origin. Once debris and other evidence can be collected the scene can be lightly cleaned to expose fire burn patterns. However, depending on the extent of fire damage, the seat of fire may have been destroyed, particularly if the fire has been burning for a significant length of time.

The growth of the fire, whether fast or slow, and its heat can be suggested by fire damage at the scene. Spalling of plaster suggests a rapid increase in temperature, though the quality of the plaster and fire-fighting efforts can distort the usefulness of this. Intense charring is indicative of a slow, smouldering fire acting as the source. Fire damage to glass can also suggest the heat of the fire. The rapid increase in temperature can cause clear breaks in the glass, whereas a very slow build-up of heat tends to cause the glass to soften rather than break. Examining the extent to which wooden structures have been charred can provide insight into the fire, as exposed wood chars at a rate related to the exposure time and amount of radiant heat.

There may be multiple seats of fire, which in some cases can indicate arson if the arsonist has started fires in numerous places. However burning wallpaper, curtains or debris can also produce apparently distinct ignition points. Due to the range of factors affecting the origin of a fire, it may not be possible to specify the exact point of ignition of a fire. Therefore investigators generally define a confidence perimeter

or radius of error. This is an extended section somewhere within which is the seat of the fire, with the most probable origin placed in the centre of the circle. Generally, the radius of this circle will decrease as the investigator becomes more confident in establishing the origin.

Establishing the Cause

Determining the cause of the fire is often greatly aided by locating the seat of fire, at which point investigators can identify characteristics or artefacts associated with ignition. The investigator will aim to establish whether the cause of the fire was accidental, natural, deliberate or undetermined. Accidental fires generally involve no malicious human contact, with examples including the malfunction of an electrical appliance or an unattended candle. Natural fires include “acts of God”, such as lightning strikes. Deliberate fires are those ignited purposely by individuals, often with malicious intent, in an act known as arson. Finally, if the cause of the fire cannot be ascertained due to lack of evidence, it may be classed as undetermined.

Evidence directly linked to the fire may be found at the point of origin, such as fuel sources, incendiary devices, electrical appliances or pools of accelerant. In addition to examining the artefacts present at the scene, the lifestyle of individuals living or working in the building should be taken into consideration. For example, factors such as whether individuals were smokers, used candles or kept large amounts of possible fuel packages such as newspapers and magazines may be relevant.

Arson

There are numerous indications of the deliberate ignition of a fire, also known as arson. Cases of arson are of particular importance to the forensic investigator, and

such incidents may arise for a variety of reasons, such as insurance fraud, terrorism, in attempts to harm a person or their property, mental health problems, or to conceal a previous crime.

A particularly significant indication of arson is the lack of evidence suggesting an accidental or natural fire, though it is possible that the cause of even an innocent fire has been destroyed and cannot be ascertained. Signs of forced entry into the premises can suggest arson, displayed through broken windows, forced doors, tools found at the scene or disabled intruder alarms.

Flammable liquids are commonly used by arsonists to accelerate a fire, particularly patrol, diesel, kerosene and turpentine. The use of accelerants is suggested by extremely localised burning patterns with clear demarcation between burnt and unburnt areas, multiple seats of fire or trailing marks, and the detection of hydrocarbon vapours using sniffer dogs or hydrocarbon detectors. Flammable liquid containers may also be found at the scene. However it must be taken into account that flammable liquids may be present for innocent purposes, therefore it is necessary to determine whether such accelerants were stored on the premises prior to the fire. Other fuel packages may also be used, such as newspaper, which may be suspiciously piled up and ignited. If an incendiary device was used to ignite the fire, evidence of the device may be found amongst the debris. Furthermore if numerous devices were used, they could be found intact if they failed to detonate.

Investigators should attempt to ascertain the contents of the building prior to the fire. The removal of items from the premises, such as business stock or objects of sentimental or monetary value, is a strong indication of arson, commonly linked to cases of insurance fraud. The owner of the premises should be investigated and

any possible financial or business problems searched for, which would provide further evidence in the form of a motive.

Fires are occasionally started to conceal a previously committed offence. However if the fire was ignited to conceal a murder, it is extremely unlikely that the victim's body will actually be completely destroyed, as this would require temperatures of hundreds of degrees Celsius for 2-3 hours.

In some cases the arsonist may make attempts to shield the cause of the fire or attempt to make it appear to be natural or accidental. For example, they may start to fire close to an appliance or pile newspapers near a potential ignition source. Arsonists may block windows to shield the fire until it has developed, or conversely prop doors open to provide ventilation. They may also place objects to hinder entrance to the building and fire-fighting efforts.

In cases of suspected arson, it may prove beneficial to observe or photograph any onlookers. Arsonists have been known to return to the scene to watch the fire and the investigation. Certain indicators at a fire scene may not only suggest arson, but can also provide an insight into the possible motives of the individual responsible. People connected to the premises should be interviewed and investigated to search for any possible motives for arson.

Electrical Fires

When an electrical current passes through any material resistance will be encountered, producing some heat. Electrical wiring is usually produced and installed in such a way that any heat produced is relatively low and will be dissipated. However there are some occasions in which the heat produced can

reach sufficient temperatures to cause ignition. Electricity is a common cause of accidental fires, often through the occurrence of an electrical arc.

An electrical arc occurs when two conductors come into contact following the insulation in the cable being damaged. This damage can occur for various reasons, particularly overheating, overloading, mechanical damage or manufacturing defects. If the cable becomes too hot, perhaps due to coiling of wires, heat will be unable to dissipate and the insulation may melt, allowing conductors to touch. Overloading occurs when more power is drawn through the cable than it is designed to handle, such as if too many plugs are inserted into one socket. This can also occur through the fitting of incorrect fuses or cable sizes. This will also cause insulation melting. Mechanical damage can occur through direct damage or continuous movement, weakening the cable at a certain point and thus allowing contact between the conductors. Similarly, damage may be the result of defects in the manufacturing process. Arcs are characterised by beading on the cable caused by the wire melting. It should be taken into account that although electrical arcs can lead to fires, fires can equally cause arcs.

If the suspected cause of the fire is an electrical appliance, the equipment must be thoroughly investigated, with a record being kept of details such as the brand, model and serial number. The expert must first conclude whether the appliance was turned on or off, whether it had a power supply, and whether the power supply was active or if the fuse had blown. Unfortunately an appliance which has caused a fire will most likely have suffered a great deal of damage and so confirming the cause of the fire may be extremely difficult or even impossible. It may be necessary to consult an expert for advice.

Upholstery Fires

The spread of a fire, the extent to which it grows and the pyrolysis products formed partly depends on the types of fuel available. In compartment fires in homes and other buildings, there will often be large amounts of upholstered furniture present, including beds, mattresses, sofas, armchairs and futons, all of which are a potential source of fuel. Upholstered furniture generally consists of a frame, filling material such as foam, and an outer covering fabric.

Various problems have been encountered with upholstered furniture in fires, particularly the flammability of materials used in their manufacture and the toxicity of materials used. In the 1970s-1980s a type of foam filling was used which produced toxic fumes when burned. The Furniture and Furnishings (Fire Safety) Regulations 1988 applied various fire resistance standards to upholstered furniture such as sofas, beds and armchairs. Following this legislation, modern upholstered furniture must include labels with fire resistance information. Furthermore, modern furniture is often produced using flame retardant textiles. For example, nitrogen and chlorine inhibit the burning rate of textiles and so are often used to treat fabrics. Other substances are added to increase the amount of charring and so create a heat barrier to prevent the fire from spreading further.

Flashover

Flashover is a phenomenon known to occur in compartment fires following a series of events, eventually resulting in the compartment's full involvement in the fire.

Radiation-induced flashover is one particular form of this. As a fire burns in the room and the fire plume cannot escape, a layer of hot gases produced by the fire rise and form at the ceiling, increasing the temperature of the upper portion of the

room. Flameover may occur, which is the fast horizontal spread of flames. As temperature increases, the rate of heat radiation increases. Temperatures at this point can reach around 600oC, with radiant heat flowing down to floor level. Soon flames across the ceiling can reach between 750 and 850oC. At this point all available combustible materials in the room can reach their auto-ignition temperature and burst into flames. This process is known as radiation-induced flashover. Furthermore, if a compartment is breached through the opening of a window or door or due to structural collapse, the influx of oxygen can result in the occurrence of an explosion known as ventilation-induced flashover.

However flashover will not occur if there is insufficient fuel, inadequate heat production, too little ventilation or too great a flow of heat out of the compartment.

Outdoor Fires

When investigating an outdoor fire, there are various differences from compartment fires that must be taken into consideration. A fire burning on a flat, open surface will move outwards towards any available fuel whilst producing hot gases above the fire. Assuming the fire is surrounded by a similar fuel source and there is no wind to take into account, the fire will most likely spread in a circular pattern. A fire on a sloped surface will most likely spread in an uphill direction, provided there is a fuel source, producing a fan-shaped spread.

Evidence Collection & Analysis

In the collection of evidence during the investigation of a fire scene, the same rigorous preservation and anti-contamination methods used in crime scene investigation should be employed.

In cases of suspected arson, samples are collected from the incident scene for the analysis of accelerants. The use of accelerants is not always apparent, therefore investigators may need to use detection dogs or hydrocarbon sniffers to detect these volatile substances. Hydrocarbon sniffers are vapour detectors used to discover the presence of fuel and solvent vapours associated with flammable liquids. Early devices implemented treated paper or crystals which changed colour when exposed to hydrocarbons, whereas more modern devices are essentially portable gas chromatographs or flame ionisation detectors. However these devices can only ever act as a preliminary test for accelerants, as similar substances can also be produced through the thermal decomposition of various natural and synthetic materials that may be found at the scene.

Once likely regions have been located, fire test samples are collected from the suspected point of ignition. In addition to this, a control sample should also be obtained, which consists of the same material as that of the fire sample but collected from an area uncontaminated by the suspected fuel, and a negative control sample. When collecting samples of possible accelerants, surface samples may be collected however, in some instances, charring of floors may be too severe. In this case samples can be collected from grooves between or beneath floorboards or even from soil below the floorboards.

All samples containing potentially volatile substances should be stored in airtight containers such as metal containers, glass jars or impervious plastic bags. All samples should be stored and submitted separately. The analysis of volatile samples is generally conducted using a technique known as headspace analysis. A common method used in the employment of headspace analysis uses a piece of activated charcoal or a similar adsorbent material which is stored in an airtight

container with the volatile sample. Volatile compounds are drawn into this material either passively or dynamically and later desorbed for analysis.

Gas chromatography is the technique most commonly utilised in the analysis of fire debris. This allows for volatile substances, whether from bulk or trace samples, to be separated, displayed in the form of a chromatogram, and identified. The technique is also able to isolate and identify mixtures of various compounds. The use of gas chromatography not only permits samples to be identified, but can also allow for numerous samples to be compared to establish whether or not they are the same substance.

4.2 Trainee's experience of fire on ships

Fire on board ship is one of the most serious risks for property and persons, as well as for the surrounding environment. A ship is evidently subject to the same risks with regard to fire as a civil or industrial land structure. On board ship there are tons of liquid fuel, electrical equipment, air-conditioning plants, engines, boilers, stores of flammable material and crew accommodation areas (kitchens, mess rooms, lounges, cabins, WCs). To all this we must add the load, which in cargo vessels consists of a high percentage of solid and liquid goods that are flammable or at least combustible, and often of a dangerous nature. In passenger ships the load consists of accommodation and entertainment facilities for the passengers and, in ferries, of a large garage for motor vehicles. Offshore rigs and tanker storage ships are essentially oil plants.

4.3 Documented reports of fires on ships and lessons learned

Your engine arrives at what appears to be a single-family dwelling with smoke and fire evident from the second-floor window on side A. You and your crew advance a

hoseline and the arriving truck company conducts a search of the building. As more units arrive, additional duties are assigned, and within 15 minutes the fire is declared under control. During overhaul, it is determined that this seemingly mundane single-family dwelling has been divided into four separate apartments. Once final extinguishment is completed, units take up and return to their quarters to ready tools and equipment for the next one. As the officer of the first unit, you must complete the report and write a narrative memorializing the actions of the company.

Fast forward six months, and you receive a call from the law office of your jurisdiction advising you that there has been a lawsuit filed regarding the illegal modification of the building and complaints from residents about the damage done to their living area and possessions. The law office has your report and sets up a meeting to discuss what happened during the incident. Does your report accurately reflect what happened during the incident, and is there sufficient detail in the report to allow you to recall the details of that day? For many, the answer would be no.

Gathering Information

Report writing is one of the dreaded duties that all firefighters and officers must deal with on a daily basis. As much as we dislike the duty, we must make sure to write factual, defensible, and accurate reports that clearly describe our actions and provide sufficient detail to stimulate our memory months or even years later. The F.I.R.E.S. method of writing will assist you in capturing the incident in a narrative form that meets all of these requirements.

F = First observation/Findings: From the time the alert is sounded, data begins to be gathered and evaluated. What information was given at dispatch? What were

the weather conditions? Were you given any additional information, such as people trapped or multiple calls, en route to the scene? Once on scene, what was your brief initial report? Did you take or pass command? What other observations did you make about the initial views of the scene? This sets the foundation of the report and helps you recall some of the details that might have seemed insignificant at the time but later turn out to be valuable. For example, all of us are ingrained to look for cars in the driveway indicating that there may be someone home; however, noting the number of vehicles in the driveway on your arrival may be an important fact when questions about the number of people home at the time of the fire are raised at a later date.

I = Investigation/Initial actions: Although not every incident is a working fire, such determination can only be made after the first-arriving company completes an investigation. Whether it is a 360-degree walk around of the building or looking in the windows during an automatic fire alarm response, a determination of what is happening must be conducted. I know of a recent incident where a door was forced in a commercial multiple occupancy retail establishment during a fire alarm sounding response. Significant damage was done to the door and a complaint was lodged with the local jurisdiction. By the time the investigation of the complaint made it down to the company level, several weeks had passed. The narrative of the report contained no information about the reasons used to make the decision to force entry into the store. The days of saying, "We forced entry because the alarm was sounding," are dwindling rapidly. Fire officers must be able to articulate their reasoning behind a decision or face enhanced scrutiny from their superiors.

This is also the area where initial actions are noted. What assignments were given to responding units? Did crews need to force entry to investigate or mitigate the

emergency? On working incidents, what size attack line was used? What was the status of the need for rescue or any injuries to occupants that required immediate care? These questions begin to hit the details that we need to capture in our report. A quick Internet search reveals multiple fire departments that have been involved in litigation because a homeowner asserted that the first-arriving unit failed in some aspect to control the situation. Accurately detailing initial actions will go a long way toward defending your work when being questioned two years later about what size hose was initially used.

R = Response to Actions: This portion of the narrative becomes the meat and potatoes of exactly what you did throughout the incident. For every action there is an opposite and equal reaction, and such circumstances need to be documented. Did you make a rescue or lead occupants to safety? Was suppression of the fire achieved with the handline that you selected? What happened to the smoke conditions once ventilation was established? These are just a sampling of the questions that the narrative should answer.

If questions arise at a later time, the details of your actions may be the only trigger to get accurate information about the incident. Don't ever underestimate when this inquiry into the incident may happen. I handled an incident at the beginning of 2014 that required a review of reports from eight years earlier. When I approached the providers and asked them for details about the prior incidents, the most common answer was, "I don't remember." The reports written during these incidents consisted of single paragraphs with the units that responded and the number of personnel. To say they were lacking details would be an understatement.

E = Evaluation: An evaluation of the incident scene and the final outcome is your next step. Exposure building information should be included here. Exposures become equally important to the overall scene. A fire in a garden-style apartment easily results in two, five, or 10 additional exposures that drive the dollar loss substantially higher. We must capture the basic information for this damage. Simply including address, occupants, owner, and a brief description of the damage is sufficient.

External factors also have an impact on the final outcome. Did you encounter a hydrant that failed to function (severe weather damage)? Were there parking or access issues, crowd control, hydrants across six lanes of busy traffic? The list goes on. Noting these external items that affected the mitigation of the incident not only describes the incident but creates a historical reference for issues encountered that require code or legislative changes. When your legislative body is being told by a construction lobbyist, "It was an anomaly," your response of, "I remember it happening more than once," carries substantially greater weight with written documentation.

S = Special Statements: Last but certainly not least is the section on special statements. At some point, the incident will end. What did we do prior to leaving? Who did we turn the scene over to? Was it the police, the homeowner, or fire investigation? Someone accepted the responsibility, and here is where we make note of it. This is also a good place to list any issues, good or bad, that didn't directly have an outcome on mitigation at the scene but still played into the overall incident. Keep in mind that the perception of the public may be slightly different from the actual actions that the responders have taken. A simple statement that services of the American Red Cross were offered to all displaced residents

validates your actions when the media runs the story from a local citizen claiming the fire department "abandoned" them after the fire. It happens, and when it does happen, written documentation assists in keeping the positive public image intact.

In the Detail

The use of the F.I.R.E.S. system of report writing undoubtedly adds work to the fire officer's duties. This system is meant to put the necessary documentation in place for an inquiry about the incident at a later date. This report is not designed to be written as a post-incident analysis but rather a factual statement of what occurred on the incident scene. This is not the place to write about your opinions of what could have been done better. This system is for documenting the facts of the incident.

This report format can be in a paragraph form or written with a bulleted list of statements that cover the areas. Whichever method is employed, proper grammar, spelling, and punctuation should be used. Don't be ashamed or embarrassed to ask someone to proofread your writing.

Submitting a complete, correct, and accurate report shows professionalism and transparency while providing historical documentation of an incident. Many of us have heard the saying "Keep fire in your life" when it comes to being prepared for battle; keeping F.I.R.E.S. in your reports will keep you prepared after the battle has been won.