

Increased institutional capacity in Danube navigation by boosting joint transnational competences and skills in education and public development services

# SAFETY PRACTICES IN EMERGENCY SITUATIONS DURING SHIP OPERATION MODULE IV – FIRE FIGHTING

Dragos FILIMON/CER Doina MUNTEANU/CER 07.02.2018



# **1. INTRODUCTION**

**These course notes were designed** both for trainers who will be involved in training of such training module and the trainees as learning aids in order to facilitate the learning process.

**The main objective** of this course compendium is to provide practical guidance on fire prevention and fire fighting with a view to preventing accidents and to ensure safety of the crew and of the vessels arising from fire prevention and fire fighting during operations of inland vessels.





# **2. LEARNING OUTCOMES**

By the end of this course, trainees will be able to:

- initiate actions on becoming aware of an emergency conform with accepted practices and procedures;
- action taken on identifying appropriate muster signals to the indicated emergency and complies with established procedures;
- use various types of extinguishers;
- use self-contained breathing apparatus;
- extinguish smaller fires;
- extinguish extensive fires with water, using jet and spray nozzles;
- extinguish fires with foam, powder or any other suitable chemical agent;
- enter and pas through, with lifeline but without breathing apparatus, a compartment into which high-expansion foam has been injected;
- fight fire in smoke-filled enclosed spaces wearing self-contained breathing apparatus;
- effect a rescue in a smoke-filled space wearing breathing apparatus.





### **3. FIRE THEORY AND FIRE CLASSIFICATION**

#### 3.1 Fire

Fire is the rapid oxidation of any combustible material. It is a chemical reaction involving fuel, heat, and oxygen.









### **3. FIRE THEORY AND FIRE CLASSIFICATION**

3.1 Fire

#### **Combustion process**

The combustion process occurs in two modes:

- the flaming;
- the non flaming, smoldering or glowing embers.

#### Stages of a fire

Incipient Fully Developed Growth Decay





# FIRE THEORY AND FIRE CLASSIFICATION Fire

**A fire begins** by an external ignition source in the form of a flame, spark, or hot ember. This external ignition source heats the fuel in the presence of oxygen.

#### Once ignition has occurred, it will continue until:

- all the available fuel or oxidant has been consumed; or
- the fuel and/or oxygen is removed; or
- by reducing the temperature by cooling; or
- by reducing the number of excited molecules and breaking the chain reaction.





### **3. FIRE THEORY AND FIRE CLASSIFICATION**

#### 3.1 Fire

#### Removal of oxygen

Except in those substances that contain their own oxygen, the removal of sufficient oxygen will extinguish a fire.

#### **Removal of heat**

A reduction in temperature is achieved by the use of a suitable cooling medium, normally water, at a sufficient rate.

#### **Removal of fuel**

The removal of fuel is not always possible. However, in the case of liquid fuel fires caused by leaking pipes or fittings, the fuel supply should be closed. It may also be possible to drain the fuel from a burning tank.

#### Breaking the chain reaction

A fire may be extinguished by breaking the chain reaction between tr species produced on ignition.





### **3. FIRE THEORY AND FIRE CLASSIFICATION**

#### 3.2 Classes of fire

**Class A fires** are fires in ordinary combustibles such as wood, paper, cloth, trash, and plastics. These solid substances are mainly of organic origin and contain carbon and its compounds.

**Class B fire** refers to a fire involving flammable liquids such as petroleum (gasoline, kerosene, petrol, diesel, octane etc.), paint, alcohol, solvent, oil and tar etc., that normally do not leave any embers or residues (or very low amounts of residues).

**Class C fires** include flammable gases such as propane and butane.











# **FIRE THEORY AND FIRE CLASSIFICATION**Classes of fire

**Class E Fires-** This type of fire involving energized electrical equipment such as motors, transformers, and appliances.



**Class F fires** are fires in cooking oils and greases such as animals fats and vegetable fats.







### **3. FIRE THEORY AND FIRE CLASSIFICATION**

#### 3.3 Sources of ignition

Ignition sources include hot surfaces, electricity, static electricity, flames, sparks or smoke. In workplace risk assessments and safety precautions, every attempt should be made to identify and avoid the accidental combination of fuel, oxygen and an ignition source in order to prevent fires.





# 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.1 Smoking and naked lights

Careless smoking tops the list of causes of fire.

Smoking is a strong habit and as such not only people tend to smoke without any regard to circumstances or location but also they hardly pay any heed to the safe disposal of lit cigarettes, cigars, pipe tobacco and matchsticks. Temperature of a burning cigarette is about 500 <sup>o</sup>C.

Smoking is therefore permitted on board a ship, only in designated smoking areas. These areas must be identified and clearly marked thus.





# 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

#### 4.2 **Spontaneous combustion and auto ignition**

Some materials when damp or soaked with paints, oils of vegetable origin in particular can ignite without external application of heat.

Auto ignition temperature of a material is the temperature at which a flammable material will ignite without initiation of a spark or flame.

Spontaneous combustion is the process of gradual increase in temperature of a material as a result of oxidation, without drawing any heat from its surrounding. This process finally results in ignition of the material concerned.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

#### 4.3 Electrical circuits and electrical equipment

Only approved electrical equipment for shipboard use that will stand the strenuous conditions are installed and/or used on board a vessel. Any electrical equipment on board must be installed, maintained, tested and repaired in accordance with existing regulations and only by qualified personnel.

a. Electrical wires that have bad insulation should be renewed;

b. Fuses and circuit breakers installed will be of proper size for their respective circuits;

c. Jury-rigging of an electrical outlet (to connect more than one appliance on one outlet) should be avoided;

d. Prior leaving cabin for work, crewmember must switch off every light bulb in the cabin. Overloading is dangerous. Only one appliance must be connected to each outlet in an electric circuit;





# 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

#### 4.4 Radio transmitting antenna

During medium and high frequency radio transmission, significant energy is radiated which can induce an electrical potential capable of producing an incentive spark, in unearthed receivers within 500 mtr range from transmitting antennae. In case antenna insulators have a surface coating of salt, dirt or water, high or medium frequency transmission can cause arcing. Low energy transmissions such as satellite communication or use of UHF/VHF communication is not considered dangerous.





# 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.5 Flammable liquids used on board vessels

Most commonly found on board are bunker fuels, lube oils of various grades, diesel oils, kerosene, paints and thinners.

#### Attention:

- Watch out for oil leaks even if minor and rectify them immediately;
- Good housekeeping goes a long way in preventing fires caused by flammable liquid splits. Any spilled liquid should be wiped off surface using rags of sawdust.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

#### 4.6.1 Machinery space

#### Methods of detection include:

- smoke, heat and flame detectors;
- high temperature probes;
- rate of rise temperature probes;
- fire patrol.

#### Fire Extinguishing System and Appliances include:

- fixed fire-extinguishing systems: e.g. using water, foam, and carbon dioxide;
- portable and mobile fire extinguishers using water, foam, carbon dioxide and dry chemical powders.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

#### 4.6.2 Accommodation

#### Methods of detection include:

- smoke, heat and flame detectors;
- sprinkler systems;
- fire patrol.

#### Fire Extinguishing Systems and Appliances Includes:

- water hydrants and hoses;
- portable extinguishers using water, foam, dry chemical powders and carbon dioxide.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

4.6.3 Ship's galley

#### Methods of detection include:

- fire patrol;
- temperature probes.

#### Fire Extinguishing Systems and Appliances include:

- fixed carbon dioxide system;
- portable fire extinguishers using carbon or dry chemical powder.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

#### 4.6.4 Galley duct protection by CO<sub>2</sub> System

#### **Operation:**

- stop power to galley;
- ensure all personnel have left the space;
- close all vents, doors and dampers;
- open the CO<sub>2</sub> cylinder valve;
- allow time for cooling before venting the duct.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

#### 4.6.5 Radio room/Battery room

#### **Methods of Detection include:**

- fire patrol;
- smoke detectors.

#### Fire Extinguishing Systems and Appliances include:

• Portable fire extinguishers using carbon or dry chemical powder.





### 4. COMMON SHIPBOARD FIRE HAZARDS AND FIRE PREVENTION

### 4.6 Shipboard locations of fire hazard

#### 4.6.6 Paint lockers

#### **Methods of Detection include:**

- smoke detectors;
- fire patrols.

#### Fire Extinguishing Systems and Appliances includes:

- water sprinkler;
- portable fire extinguisher.





### **5. TYPES OF FIRE EXTINGUISHERS**

### 5.1 **Requirements for fire- fighting equipment**

5.1.1 **Portable fire extinguishers** 

There shall be at least one portable fire extinguisher in accordance with European standard EN 3:1996 at each of the following places:

- in the wheelhouse;
- close to each entrance from the deck to accommodation spaces;
- close to each entrance to service spaces which are not accessible from the accommodation spaces and which contain heating, cooking or refrigeration equipment using solid or liquid fuels or liquefied gas;
- at each entrance to engine rooms and boiler rooms;
- at suitable points below deck in engine rooms and boiler rooms such that no position in the space is more than 10 metres walking distance away from an extinguisher.





### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.1 **Requirements for fire- fighting equipment**

5.1.2 Permanently installed fire-fighting systems in accommodation spaces, wheelhouses and passenger spaces

Fire protection in accommodation spaces, wheelhouses and passenger spaces is to be provided only by suitable automatic pressurised water sprinklers as permanently installed fire-fighting systems.





### **5. TYPES OF FIRE EXTINGUISHERS**

### 5.1 **Requirements for fire- fighting equipment**

5.1.3 Permanently installed fire-fighting systems in engine rooms, boiler rooms and pump rooms

#### **Extinguishing agents**

For protecting engine rooms, boiler rooms and pump rooms, the following extinguishing agents may be used in permanently installed fire-fighting systems:

- CO<sub>2</sub> (carbon dioxide);
- HFC 227ea (heptafluoropropane);
- Inert Gas-541 (52 % nitrogen, 40 % argon, 8 % carbon dioxide).





### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

#### 5.2.1 Water as extinguishing agent and types of water extinguishers

Water is usually present in large quantities. Water is relatively easy to use. Due to its high capacity as a thermal conductor, water has a high cooling effect.

Another positive side effect is the formation steam during extinguishing that has a suffocating effect on the fire.





### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

5.2.1 Water as extinguishing agent and types of water extinguishers

Water extinguisher

#### Signal Red

Best For

Fires involving organic solid materials such as wood, cloth, paper, plastics, coal etc.

Danger

Do not use on burning fat or oil or on electrical appliances.

How to Use

Point the jet at the base of the flames and keep it moving across the area of the fire. Ensure that all areas of the fire are out.

How it Works

Water has a great cooling effect on the fuel's surface and thereby reduces the pyrolysis rate of the fuel.







### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

5.2.1 Water as extinguishing agent and types of water extinguishers

Water spray extinguisher (water with additive)

Signal Red	
Best For	
Fires involving organic sol These offer significantly in type water fire extinguishe	lid materials such as wood, cloth, paper, plastics, coal etc. aproved fire - fighting capability compared to traditional jet rs.
Danger	
Do not use on burning fat o	r oil or on electrical appliances.
How to Use	
Point the jet at the base o keep it moving across the a	f the flames from a safe distance of approx. 3 meters and rea of the fire. Ensure that all areas of the fire are out.
How it Works	
	Water has a great cooling effect on the fuel's surface and thereby reduces the pyrolysis rate of the fuel. Instead of a jet nozzle a spray nozzle is used, with a higher pressure, which creates a fine spray. This allows for a given quantity of water to have a considerable increase in the surface area presented to the fire. This makes extinguishing more efficient by more rapid extraction of heat, formation of steam etc. They can also contain surfactants which help the water penetrate deep into the burning material which increases the effectiveness of the extinguisher.





### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

5.2.1 Water as extinguishing agent and types of water extinguishers

Water mist extinguisher ("dry" water mist)

#### Signal Red on a White Background

Best For

The first broad spectrum extinguisher to tackle A, B, C rated risks as well as fats and deep fat fryers (Class F). Models with dielectric test to 35k Volts can be safely used on electrical fires (up to 1000 Volt) if a safety distance of 1m is adhered to, as their mist (de-ionized water) does not conduct electricity and the extinguisher does not normally form puddles, which could conduct electricity.

Point the jet at the base of the flames from a safe distance of approx. 3meters and keep it moving across the area of the fire. Ensure that all areas of the fire are out. The fire draws the microscopic water particles into the fire.

How it Works

Water is turned into microscopic particles in the supersonic nozzle. The water mist is drawn to the fire where it cools and suffocates the fire. The mist also forms a safety barrier between user and fire, which keeps some of the heat back.





### **5. TYPES OF FIRE EXTINGUISHERS**

5.2

#### Types of extinguishing agents and fire extinguishers

5.2.2 Carbon dioxide as extinguishing agent and types of carbon dioxide extinguishers







### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

5.2.3 Foam as extinguishing agent and types of foam extinguishers







### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

#### 5.2.4 **Powder as extinguishing agent and types of powder extinguishers**

#### Powder extinguisher multi-purpose

#### Danger

Safe on live electrical equipment, although does not penetrate the spaces in equipment easily and the fire may re-ignite. This type of extinguisher does not cool the fire very well and care should be taken that the fire does not flare up again. Smouldering material in deep seated fires such as upholstery or bedding can cause the fire to start up again. Do not use on domestic chip or fat pan fires. There is danger of inhalation if powder extinguishers are used within buildings. Due to this, and the potential for powder to impair vision, powder extinguishers are no longer recommended for use within enclosed spaces.

#### How to Use

Point the jet or discharge horn at the base of the flames and, with a rapid sweeping motion, drive the fire towards the far edge until all the flames are out. If the extinguisher has a hand control, wait until the air clears and if you can still see the flames, attack the fire again. Recommended safe distance 3-5 meters.

#### How it Works

Similarly to almost all extinguishing agents the powder acts as a thermal ballast making the flames too cool for the chemical reactions to continue. Some powders also provide a minor chemical inhibition, although this effect is relatively weak. These powders thus provide rapid knockdown of flame fronts, but may not keep the fire suppressed.







### **5. TYPES OF FIRE EXTINGUISHERS**

- 5.2 Types of extinguishing agents and fire extinguishers
- 5.2.4 Powder as extinguishing agent and types of powder extinguishers

Dry powder extinguisher (special powder)







### **5. TYPES OF FIRE EXTINGUISHERS**

**5.2** 5.2.5

#### **Types of extinguishing agents and fire extinguishers** Wet chemical extinguishers

#### **Canary Yellow**

#### Best For

Wet chemical fire extinguishers are ideal for Class F fires, involving cooking oils and fats, such as lard, olive oil, sunflower oil, maize oil and butter.

#### Danger

Check manufacturer's instructions for suitability of use. These extinguishers are usually not recommended for class B fires such as petrol.

#### How to Use

Apply the wet chemical using the extended applicator in slow circular movements, which gives a gentle, yet highly effective application. Apply the fine spray onto the burning fat until the surface of the burning cooking oil changes into a soapy like substance which prevents re-ignition. The gentle application helps to prevent burning oil splashing out of the container. Make sure that you empty the entire content of the wet chemical extinguisher onto the oil/fat, as the fire can re-ignite otherwise.

#### How it Works

Most class F extinguishers contain a solution of potassium acetate, sometimes with some potassium citrate or potassium bicarbonate. The extinguishers spray the agent out as a fine mist. The mist acts to cool the flame front, while the potassium salts saponify the surface of the burning cooking oil, producing a layer of foam over the surface. This solution thus provides a similar blanketing effect to a foam extinguisher, but with a greater cooling effect. The saponification only works on animal fats and vegetable oils, so most class F extinguishers cannot be used for class B fires. The misting also helps to prevent splashing the blazing oil.







### **5. TYPES OF FIRE EXTINGUISHERS**

#### 5.2 Types of extinguishing agents and fire extinguishers

5.2.6 Fire extinguishers for electrical fire

The essential action in the event of an electrical fire is to cut off the source of electrical supply. To avoid the spread of fire it will frequently be necessary to fight an electrical fire before the electric supply has been cut off. The fire-fighting medium must therefore be a non-conductor of electricity.  $CO_2$  gas does not conduct electricity and is the most suitable medium for extinguishing electrical fires.

Powder extinguishers can also be used and are equally efficient, if it is possible to reach the source of the fire.





# 6. EMERGENCY PROCEDURE

### 6.1 Use of fire extinguisher

#### General instructions for use:

- 1. Before using the fire extinguisher, ensure you have selected the correct extinguisher for the class of fire that you intend to fight;
- 2. Ensure that you are positioned between the fire and a safe exit or escape route. 3. Pull out safety pin firmly (this will be held in by an anti-tamper seal device);
- 3. Apply the powder rapid sweeping in bursts across the flame front and/or sweeping up the flames keeping out of the smoke & powder;

If the fire is not out on completion of the extinguisher's contents, then leave immediately by a safe route from the building, closing all doors behind you.





# 6. **EMERGENCY PROCEDURE**

#### **6.2 Operating instructions** *For portable CO2 extinguishers*







3. Direct nozzle at the base of the fire



1. Pull out safety pin

2. Squeeze the handle



# 6. EMERGENCY PROCEDURE

**6.3 Personal equipment** 







# 6. EMERGENCY PROCEDURE

#### 6.4 Breathing apparatus







### 6. EMERGENCY PROCEDURE

6.5 Emergency Escape Breathing Devices (EEBD)







# 6. EMERGENCY PROCEDURE

### 6.6 Fire-fighting organisation

The crew members of the vessel are required to have basic skills and competence for efficient intervention in case of fire.

These requirements are as follows:

- 1. Use of various portable fire extinguishers;
- 2. Use of BA (breathing apparatus);
- 3. Extinguishing smaller fires, electrical, oil etc.;
- 4. Extinguishing fires using jet and spray nozzles with water;
- 5. Extinguish fires using foam, powder and chemical agents;
- 6. Entering and passing through a compartment with high expansion foam using no Breathing Apparatus;
- 7. Fighting fires in enclosed spaces using Breathing Apparatus;
- 8. Use fog or steam for fire suppression;
- 9. The above standards can be tested during the compulsory fire drill.





# 6. EMERGENCY PROCEDURE

#### 6.6 Fire-fighting organisation

#### 6.6.1 Fire drill

A successful meaningful drill requires thought before the drill begins, firstly defining the learning objectives, setting the timing and allocating time to debrief afterwards. The objectives must reflex key tasks to be performed and must be measurable against a standard i.e. one objective could be to dress effectively in fire outfits and breathing apparatus within a fixed time frame, effectively means skin is fully protected and the start - up tests are performed on the breathing apparatus.

Once the objectives are set, a scenario can be written, which incorporates specific events and consequences of certain actions, the script should test all of the crew.

The drill begins with a report of fire and subsequent sounding of the alarm, indicating that it is a drill, but trying to bring an element of surprise and realism.





# 6. EMERGENCY PROCEDURE

### 6.6 Fire-fighting organisation

#### 6.6.2 Leadership

The approach to leadership in emergency situations is based on a system used by fire and emergency services; it is called functional leadership which analyses the functions involved in dealing with an emergency.

A better approach is to analyse the functions involved. Leadership can only be applied to groups who are confronted with a need to take action or make decisions.

Within a group, 3 areas of need exist:

- 1. task needs;
- 2. team maintenance needs;
- 3. individual needs.





### 6. EMERGENCY PROCEDURE

#### 6.7 Location of fire-fighting appliances and detection systems

The fire control plan illustrates the location of fire-fighting appliances and equipment onboard. The plan shows the vessels profile and an overview of each deck.







# **Thank you for your attention!**

