
Manuel Ventura
Fire Protection, Detection and Extinguishing (1)

- This Chapter was totally reviewed in the Amendments published on December 2000 [Resolution MSC.99 (73)]
- Entry into force on the 1st of July 2002

Alterations:
- The new version focus the attention more on the processes associated to fire scenarios than on the types of ships, as previously.
- New Part E - Operational Requirements that deals exclusively with the human factors, such as education, training and maintenance issues.
- New Part F that establishes a methodology for the approval of alternative or innovative designs and arrangements.
- Some technical details of the systems have been moved to the International Fire Safety Systems (FSS) Code.

Fire Protection, Detection and Extinguishing (2)

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- Regulation 2. Fire safety objectives and functional requirements
- Regulation 3. Definitions

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- Regulation 5. Fire growth potential
- Regulation 6. Smoke generation potential and toxicity
PART C - SUPPRESSION OF FIRE
- Regulation 7. Detection and alarm
- Regulation 8. Control of smoke spread
- Regulation 9. Containment of fire
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PART A - GENERAL

Reg. 1 - Application

1. Application
2. Applicable requirements to existing ships
3. Repairs, alterations, modifications and outfitting
4. Exemptions
5. Applicable requirements depending on ship type
6. Application of requirements for tankers
Reg. 2 - Fire safety Objectives and Functional Requirements

1. Fire safety objectives
2. Functional requirements
3. Achievement of the fire safety objectives

Fire Safety Objectives

- Prevent the occurrence of fire and explosion;
- Reduce the risk to life caused by fire;
- Reduce the risk of damage caused by fire to the ship, its cargo and the environment;
- Contain, control and suppress fire and explosion in the compartment of origin;
- Provide adequate and readily accessible means of escape for passengers and crew.
Functional Requirements

- Division of the ship into main vertical and horizontal zones with structural and thermal boundaries
- Separation of the accommodations from the remainder of the ship with structural and thermal boundaries
- Restricted use of combustible materials
- Detection of any fire in the zone of origin
- Containment and extinguishing of any fire in the compartment of origin
- Protection of the means of escape and access for firefighting
- Fire firefighting appliances available and ready
- Minimize the possibility of ignition of flammable cargo vapor

Some Definitions (1)

- **Accommodation Spaces** - spaces used for public spaces, corridors, lavatories, cabins, offices, hospitals, cinemas, game and hobby rooms, barber shops, pantries containing no cooking appliances and similar spaces

- **Category A Machinery Spaces** - are the spaces and the trunks for the spaces that contain:
  - Internal combustion engines used for propulsion
  - Other internal combustion engines that all together have a total power > 375 kW
  - Any oil fired boiler or other oil burning equipment (inert gas generators, incinerators, etc.)
Some Definitions (2)

- **Non-Combustible Materials** - materials that do not burn or release flammable vapors up to 750°C, during the standard fire test.

- **Standard Fire Tests** - tests carried out in an oven, in which parts of the relevant bulkheads or deck are raised to temperatures corresponding to the standard time-temperature curve. The tested parts must:
  - Have an exposed area not less than 4.65 m² and height (or length) not less than 2.44 m.
  - Include a joint (where appropriate)

Some Definitions (3)

- The **standard time-temperature curve** is a fair curve interpolating the following points measured above the initial temperature of the oven:

<table>
<thead>
<tr>
<th>Time</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 min</td>
<td>556°C</td>
</tr>
<tr>
<td>10 min</td>
<td>659°C</td>
</tr>
<tr>
<td>15 min</td>
<td>708°C</td>
</tr>
<tr>
<td>30 min</td>
<td>823°C</td>
</tr>
<tr>
<td>60 min</td>
<td>925°C</td>
</tr>
</tbody>
</table>
Some Definitions (4)

**Class A Divisions**
- Built in steel or other equivalent material
- Suitably stiffened
- Built to be capable of preventing the passage of smoke and flame to the end of the one-hour
- Insulated with approved non-combustible materials such that the average temperature of the unexposed side will not rise more than 140°C above the original temperature, nor will the temperature, at any one point, including any joint, rise more than 180°C above the original temperature, within the following time intervals:
  - A60 - 60 min.
  - A30 - 30 min.
  - A15 - 15 min
  - A0  - 0 min.

Some Definitions (5)

**Class B Divisions**
- Constructed of approved non-combustible materials
- Built to avoid the passage of flames during at least 30 minutes of the standard test
- Insulated such that the average temperature of the unexposed side will not rise more than 140°C, nor will the temperature at any one point, including any joint, rise more than 225°C above the original temperature, after:
  - B15 - 15 min.
  - B0  - 0 min.

**Class C Divisions**
- Constructed of approved non-combustible materials, without any particular requirements.
PART B - PREVENTION OF FIRE AND EXPLOSION

Cargo Tank Venting (Oil Tankers)

- The venting systems of cargo tanks shall be entirely distinct from the air pipes of the other compartments of the ship.
- Shall be designed to minimize the possibility of flammable vapours being admitted to enclosed spaces containing a source of ignition.
- The venting arrangements in each cargo tank may be independent or combined with other cargo tanks.
- May be incorporated into the inert gas piping.
Cargo Tank Venting (cont.)

- Vent outlets for cargo loading, discharging and ballasting shall:
  - Permit the free flow of vapour mixtures, or
  - Permit the throttling of the discharge of the vapour mixtures to achieve a velocity $\geq 30 \text{ m/s}$;
  - Be so arranged that the vapour mixture is discharged vertically upwards

- Where the method is by **free flow** the outlets shall be located at:
  - Height $> 6 \text{ m above deck}$
  - More than 10 m apart from any air intakes for confined spaces containing possible sources of ignition and from deck machinery

- Where the method is by **high-velocity discharge**, the outlets shall be located at:
  - Height $> 2 \text{ m above deck}$
  - More than 10 m from the nearest air intakes and from deck machinery
  - The outlets shall be provided with high-velocity devices

Part C. Suppression of Fire
Detection and Alarm

1. Purpose
2. General requirements
3. Initial and periodical tests
4. Protection of machinery spaces
5. Protection of accommodation and service spaces and control stations
6. Protection of cargo spaces in passenger ships
7. Manually operated call points
8. Fire patrols in passenger ships
9. Fire alarm signaling systems in passenger ships

Control of Smoke Spread

1. Purpose
2. Protection of control stations outside machinery spaces
3. Release of smoke from machinery spaces
4. Draught stops
5. Smoke extraction systems in atriums of passenger ships
Containment of Fire

1. Purpose
2. Thermal and structural boundaries
3. Penetration in fire resisting divisions and prevention of heat transmission
4. Protection of openings in fire-resisting divisions
5. Protection of openings in machinery spaces boundaries
6. Protection of cargo space boundaries
7. Ventilation systems

Fire Fighting

1. Purpose
2. Water supply systems
3. Portable fire extinguishers
4. Fixed fire extinguishing systems
5. Fire-extinguishing arrangements in machinery spaces
6. Fire extinguishing arrangements in control stations, accommodation and service spaces
7. Fire extinguishing arrangements in cargo spaces
8. Cargo tank protection
9. Protection of cargo pump-rooms in tankers
10. Fire-fighter's outfits
Fixed Fire Fighting System

- Ships shall be provided with fire pumps, fire mains, hydrants and hoses

Capacity of the Fire Pumps:

- **Passenger Ships**
  - Not less than $2/3$ of the flow rate of the bilge pumps.

- **Cargo Ships**
  - Not less than $4/3$ of the flow rate of the bilge pumps of a passenger ship with the same dimensions.
  - Total does not need to be greater than $180 \text{ m}^3/\text{h}$.

Fire Pumps

Capacity of the Fire Pumps (cont.):

- Each of the required fire pumps (other than any emergency pump required for cargo ships) shall have a capacity $\geq 80\%$ of the total required capacity divided by the minimum number of required fire pumps.

- None of the pumps may have a capacity $< 25 \text{ m}^3/\text{h}$.

- Each pump must capable in every circumstance, of delivering the two water jets required.
Fire Mains

Diameter of the Fire Mains
- Shall be sufficient for the effective distribution of the maximum required discharge from 2 fire pumps operating simultaneously.
- In cargo ships the diameter need only be sufficient for the discharge of 140 m³/h.

Pressure in the Fire Mains
- With two pumps in simultaneously delivering water, it must capable of guaranteeing the following pressures in any adjacent hydrants

<table>
<thead>
<tr>
<th></th>
<th>Passenger Ships</th>
<th>Cargo Ships</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRT &lt; 4000</td>
<td>0.30 N/mm²</td>
<td>GRT &lt; 6000</td>
</tr>
<tr>
<td>GRT ≥ 4000</td>
<td>0.40 N/mm²</td>
<td>GRT &gt; 6000</td>
</tr>
</tbody>
</table>

Fire Pumps

Arrangement of Fire Pumps and Fire Mains
- Minimum number of pumps, independently driven:

<table>
<thead>
<tr>
<th></th>
<th>GT &gt;= 4000</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger Ships</td>
<td>GT &lt; 4000</td>
<td>2</td>
</tr>
<tr>
<td>Cargo Ships</td>
<td>GT &gt;= 1000</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>GT &lt; 1000</td>
<td>2*</td>
</tr>
</tbody>
</table>

* Only 1 needs to be independently driven
Fire Hoses and Nozzles

- Fire hoses shall be of non-perishable material approved by the Administration and shall be sufficient in length to project a jet of water to any of the spaces in which they may be required to be used.
- Each hose shall be provided with a nozzle and the necessary couplings.
- Fire hoses shall have a length of at least 10 m, but not more than:
  - 15 m in machinery spaces
  - 20 m in other spaces and open decks
  - 25 m for open decks on ships with B > 30 m

Portable Fire Extinguishers

- Ships with GRT > 1,000 shall have at least 5 portable fire extinguishers distributed in the accommodation area, service areas and control stations.
- One of the portable fire extinguishers intended for use in any space shall be stowed near the entrance to that space.
- CO2 extinguishers shall not be used in accommodation spaces.
- The distribution in the accommodation space shall be as follows:
  - In passenger ships, inside each vertical zone, no point shall be at more than 15 m from an extinguisher
  - In cargo ships, 1 in each deck.
- Fire extinguishers shall be situated ready for use at easily visible places, which can be reached quickly and easily at any time.
- Portable fire extinguishers shall be provided with devices which indicate whether they have been used.
Fixed Systems for Fire Fighting

- **Fixed Gas Systems**
  - Carbon Dioxide
  - Steam
  - Other
- **High Expansion Foam Systems**
- **Fixed Pressure Water-Spraying Systems**

Systems based on Halon were banished by SOLAS since 1994 and by the EU regulation EC 2037/2000 since 2003, due to the damages caused to the ozone layer.

**Fixed Gas Systems (1)**

**Carbon Dioxide Systems**
- **Cargo Spaces** - the volume available shall be greater than 30% of the volume of the larger cargo space protected
- **Machinery Spaces** - the volume available shall be greater than the maximum of the following values:
  - 40% of the volume of the larger machinery space protected, excluding the part of the roof above the level at which the horizontal area of the roof is 40% or less of the horizontal area of the space measured at mid height between the double-bottom and the base of the roof
  - 35% of the gross volume of the larger machinery space protected, including the roof
- The specific volume of the free CO₂ shall be computed at 0.56 m³/kg
- The piping system shall guarantee that 85% of the gas is delivered in less than 2 minutes
Fixed Gas Systems (2)

Steam Systems

- In general vapor is not allowed as fire extinguishing in fixed systems
- It shall be only eventually allowed in very restrict zones, as an additional mean, and with the guarantee that the boilers available to feed the system have a minimum flow rate of 1.0 kg/h for each 0.75 m³ of the gross volume of the larger space protected

Fixed Gas Systems (3)

Other Gas Systems

- If other gases besides the above mentioned are used as a mean of fire extinguishing, they shall be the result of the combustion of fuels, in which the contents of oxygen, carbon monoxide and corrosive elements have been reduced to a minimum admissible.
- When these systems are used, the flow rate shall be ≥ 25% of the gross volume of the larger compartment protected, within a period of 72 hours.
Fixed Pressure Water-Spraying Systems (Water Mist)

• System introduced as an alternative to the Halon systems (prohibited in 1994) for fire fighting in machinery spaces of category A and cargo pump rooms.

• This fire extinguishing process is based in 3 mechanisms:
  • Cooling of the flames
  • Reduction of the oxygen content by the displacement of the air by the expansion of the water vapor
  • Diminution of the radiating heat

• Mandatory in passenger ships with GT > 500 and cargo ships with GT > 2000, for fire extinguishing in machinery spaces of category A with volume > 500 m³ (IMO MSC/Circ.913).

• It shall be activated automatically by 2 different types of detectors: flame and smoke.

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Fixed Pressure Water-Spraying Systems (Water Mist)

• The requirements for test and approval of these systems are specified in the MSC/Circ.1165:
  - It shall be capable of being activated manually
  - It shall be always ready to function and be capable of supplying water during 30 minutes, to avoid the re-ignition of the fire
  - The systems that operate with a reduced output after an initial discharge, shall be ready again in less than 5 minutes
  - It shall have redundant pumping means and shall have a permanent sea chest
  - The means of control shall be outside the protected spaces
  - It shall be supplied with electric power from the main and emergency generators
  - The capacity of the system shall be based in the largest of the protected areas

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Fixed Water Mist Systems

- The pressurized water in contact with the fire vaporizes and it is converted into steam.
- This process absorbs much energy lowering the temperature of the fire and the pressurized water expands about 1700 times taking the air away from the fire.
- These systems require a water consumption 6 to 10 times lower than a traditional sprinkler system.

<table>
<thead>
<tr>
<th>Type</th>
<th>Conventional Sprinkler System</th>
<th>XFlow* Water Mist System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure at nozzle</td>
<td>13 bar</td>
<td>4 bar</td>
</tr>
<tr>
<td>Way of extinguishing</td>
<td>Cooling</td>
<td>Cooling and suffocation</td>
</tr>
<tr>
<td>System configuration</td>
<td>Heavy</td>
<td>Simple</td>
</tr>
<tr>
<td>Price</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Water consumption</td>
<td>5 l/min/m²</td>
<td>1.6 l/min/m²</td>
</tr>
<tr>
<td>Pipe size</td>
<td>Large</td>
<td>Small</td>
</tr>
<tr>
<td>Recommended pipe material</td>
<td>Black steel</td>
<td>Stainless steel, copper piping</td>
</tr>
<tr>
<td>Pump working pressure</td>
<td>10 bar</td>
<td>&lt; 13.1 bar</td>
</tr>
<tr>
<td>Fitting</td>
<td>Sprinkler fitting</td>
<td>Press fitting</td>
</tr>
<tr>
<td>Maximum area covered per nozzle</td>
<td>12 m²</td>
<td>25 m²</td>
</tr>
</tbody>
</table>

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Fire Fighting Syst. in Machinery Spaces (1)

The machinery spaces are classified in the following types:

1. Spaces with boilers or with fuel oil burning units
2. Spaces with internal combustion engines
3. Closed spaces with steam turbines or steam engines
4. Other machinery spaces

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1. Spaces with Boilers or Oil Burning Units
   Shall have any one of the following fixed systems:
   - Fixed gas system
   - High expansion foam system
   - Pressurized spraying water system
   Shall have at least 2 portable foam fire extinguishers

2. Spaces with internal combustion engines
   Shall have any one of the following fixed systems:
   - Fixed gas system
   - High expansion foam system
   - Pressurized spraying water system
3. Spaces with Steam Turbines or Enclosed Steam Engines
   When the total power is > 375 kW shall have:
   - Foam extinguishers, with at least 45 liters capacity each
   - A sufficient number of portable extinguishers, with at least 2, located in such a way that in no point of the space one is more than 10 m from an extinguisher
   - Shall have any one of the following fixed systems:
     • Fixed gas system
     • High expansion foam system
     • Pressurized spraying water system

4. Other Machinery Spaces
   Whenever it is considered to exist the danger of fire in any machinery space other than the previously mentioned, a sufficient number of portable fire extinguisher shall exist.
Fixed Low Expansion Foam Fire Fighting Syst. for Machinery Spaces

• Shall be able to discharge through fixed nozzles the amount of foam necessary to cover in less than 5 minutes, a height of 150 mm of the largest area were fuel oil may have been spread.

High Expansion Foam Systems in Machinery Spaces

• Shall discharge through fixed nozzles the quantity of foam necessary to fill the largest space protected with a speed not inferior to 1 meter of height/minute.
• The quantity of liquid available to generate foam shall be sufficient to produce a volume of foam equal to 5 times the volume of the largest space protected.
• The foam expansion ratio shall not exceed 12:1.
Fixed Pressurized Water Spraying Syst. in Machinery Spaces

- The number of sprinklers shall be so that the water distribution in the protected spaces is 5 liters/m² minimum.
- The system can be divided in sections and the respective distribution valves shall be operated from outside the protected spaces.
- The system shall be always kept charged and the feeding pump will be triggered automatically in case of pressure drop.
- The pump shall be capable of supplying water to all the sections simultaneously.
- The pump shall be located outside of the protected spaces.
- The pump shall be driven by an independent internal combustion engine.

Fire-Extinguishing Arrangements in Control Stations, Accommodations and Service Spaces

- Passenger ships with N > 36 shall be equipped with automatic sprinkler, fire detection and fire alarm system.
Fire-extinguishing Arrangements in Cargo Spaces

- Cargo spaces of passenger ships of GT ≥ 1,000 shall be protected by a fixed CO2 or inert gas fire-extinguishing system.
- Except for Ro-Ro and vehicle spaces, cargo spaces on cargo ships of GT ≥ 2,000 shall be protected by a fixed CO2 or inert gas fire-extinguishing system.

Drainage of Fire-Fighting Water from Closed Vehicle and Ro-Ro Spaces

- Guidelines for the drainage of fire-fighting water from closed vehicle and Ro-Ro spaces and special category spaces of passenger and cargo ships (MSC.1/Circ.1320) for the requirements of amended SOLAS Reg.II-2/20.6.1.5 effective from 1 January 2010 by Res.MSC.256(84).
- On all ships, for closed vehicles and Ro-Ro spaces and special category spaces, where fixed pressure water-spraying systems are fitted, means shall be provided to prevent the blockage of drainage arrangements, taking into account the guidelines MSC.1/Circ.1320.
- Ships constructed before 1 January 2010 shall comply with the requirements by the initial survey after 1 January 2010. Ships constructed on or after 1 January 2010 shall comply with the requirements by the initial survey.
Protection of drain opening

1. An easily removable grating, screen or other means should be installed over each drain opening in the protected spaces to prevent debris from blocking the drain.

   The total open area ratio of the grating to the attached drain pipe should be at least 6 to 1.

   The grating should be raised above the deck or installed at an angle to prevent large objects from blocking the drain.

   No dimension of the individual openings in the grating should be more than 25 mm.

   Example of drain opening protected by a removable grating

2. No grating or screen is required when a fixed mechanical system is provided to unblock the drainage system, or when other than a gravity drain system is provided with its own filter.

3. A clearly visible sign or marking should be provided not less than 1,500 mm above each drain opening stating, "Drain opening - do not cover or obstruct".

   The marking should be in letters at least 50 mm in height.
• Applies to all the new tankers carrying oil or derived oil products in bulk whose flashpoint does not exceed 60°C

Protection of the Cargo Tanks (Oil Tankers)

• In tankers with DW > 20,000 t the protection of the cargo zone will be assured by:
  - Fixed Foam System (decks over the cargo tanks)
  - Inert Gas System (cargo tanks)
• The Administration may accept other combinations of fixed installations if they offer equivalent protection
Fixed Foam System on Deck (Oil Tankers)

- The foam supply rate shall not be less than the larger of the following values:
  - 0.6 l/min per m² of the area of cargo tanks, calculated as the product of the maximum breadth by the length of the cargo area
  - 6 l/min per m² of the maximum horizontal section of an individual tank
  - 3 l/min per m² of the area protected by the largest monitor, entirely forward of it, but not less than 1250 l/min.

Fixed Foam System on Deck (cont.)

- The distance from the foam monitor to the farthest point of the area protected shall not be superior to 75% of the monitor range

- Forward of the stern castle or of the superstructure, 2 foam monitors shall be installed, one at each side, facing the cargo area.
Location and Separation of Spaces (Oil Tankers)

- The machinery spaces of category A shall be located aft of the cargo tanks and slop tanks and be isolated from them by a cofferdam, a cargo pump room or a fuel oil tank.

- The accommodation spaces, cargo control rooms, control stations and service spaces shall be located aft of all the cargo tank, slop tanks, cargo pump rooms and cofferdams that divide the cargo or slop tanks from the machinery spaces of category A.

Restrictions for Openings in Boundary Bulkheads

- Access doors, air intakes and openings for accommodation spaces, service spaces, control stations and machinery spaces will not be facing the cargo zone.

- Shall be located on the transverse bulkhead not facing the cargo area or on the sides of the superstructure or deckhouse at a distance $d$ from the extremity of the superstructure or deckhouse, so that:

$$MIN \left(0.04 \cdot L, 3m\right) \leq d < 5m$$
Location and Separation of Spaces
(Oil Tankers)

Windows and Scuttles

• Windows and scuttles facing the cargo area and at the sides of the superstructure and deckhouses inside the specified limits shall be of the fixed type (do not open).

• Those windows and scuttles, with the exception of the bridge windows, shall be built in accordance to the "A-60" standard.

Exceptions accepted by the Administration

• The Administration can allow access doors in bulkheads facing the cargo area, if they do not provide direct or indirect access to any other space containing or leading to accommodation, control stations or service areas such as galleys, pantries or workshops, or similar spaces containing sources of ignition of gases.

• The boundary of such space shall be insulated by A60 bulkheads, with the exception of the bulkhead facing the cargo area.

• The doors and windows of the bridge may be located inside the defined limits if they are designed to guarantee that the bridge may be sealed in a fast and efficient way against gases and vapors.
Fire Resistance of Bulkheads and Decks (Oil Tankers)

- All the bulkheads and decks shall have as minimum fire resistance the class indicated in the following tables.

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### Bulkheads Separating Adjacent Spaces

<table>
<thead>
<tr>
<th>Spaces</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
<th>(7)</th>
<th>(8)</th>
<th>(9)</th>
<th>(10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Stations (1)</td>
<td>AO</td>
<td>AO</td>
<td>A60</td>
<td>AO</td>
<td>A15</td>
<td>A60</td>
<td>A15</td>
<td>A60</td>
<td>A60</td>
<td>*</td>
</tr>
<tr>
<td>Corridors (2)</td>
<td>C</td>
<td>B0</td>
<td>B0</td>
<td>B0</td>
<td>A60</td>
<td>AO</td>
<td>A60</td>
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<td>Accommodation Areas (3)</td>
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<td>AO</td>
<td>A60</td>
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<td>Stairs (4)</td>
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<td>AO</td>
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<td>Low Risk Service Spaces (5)</td>
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<tr>
<td>Machinery Spaces Category A (6)</td>
<td>*</td>
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<tr>
<td>Other Machinery Spaces (7)</td>
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<tr>
<td>Cargo Pump Room (8)</td>
<td>*</td>
<td>A60</td>
<td>*</td>
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<td>High Risk Service Spaces (9)</td>
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<td>Open decks (10)</td>
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</tbody>
</table>

* Built in steel or equivalent material, but not necessarily class A.
Decks Separating Adjacent Spaces

<table>
<thead>
<tr>
<th>Spaces</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
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</table>

* Built in steel or equivalent material, but not necessarily class <A>

Inert Gas System (Oil Tankers)

- The system shall be capable of:
  - Inertize empty cargo tanks, reducing the oxygen content to values at which the combustion cannot occur
  - Maintain the atmosphere in any part of any cargo tank with oxygen content less than 8% in volume and always with positive pressure, in port or sailing
  - Eliminate the necessity to introduce air inside the tanks during normal operation
  - Purge empty cargo tanks from hydrocarbon
Inert Gas System (Oil Tankers)

General Diagram of the System

- The system shall have a flow rate greater than 125% of the maximum discharge capacity of the ship, expressed in volume.
- The inert gas supplied shall not have an oxygen content superior to 5%, in volume.
- The inert gas can be obtained from exhaust gases of main and auxiliary boiler, duly treated.
- At least 2 ventilators shall be installed, that all together can be capable of supplying the flow required to the cargo tanks.

Inert Gas System
A scrubber shall be installed to cool a specified volume of inert gas and to remove solid and sulphur products from the combustion.
**Inert Gas System**

- On the deck, between the scrubber and the manifold at least 2 non-return devices shall be installed, one of which can be a water seal and the other can be a non-return valve.

**Cargo Pump Rooms (Oil Tankers)**

- Each pump room shall be equipped with one of the following fire extinguishing systems, operated from the outside:
  - Carbon Dioxide
  - High expansion foam
  - Fixed pressure water-spraying
- Shall be provided with a mechanical ventilation system, dimensioned to guarantee 20 renov/h.
- The system shall be of insufflations and the ventilators of the anti-sparking type.
Fireman Outfit

- In general, the ship shall have at least 2 fireman outfits
- Passenger ships shall have 2 more outfits for each 80 m of length of the passenger spaces and service spaces
- Passenger ships with N > 36 shall have 2 more outfits for each vertical zone
- Tankers shall have 2 additional outfits

Structural Integrity

1. Purpose
2. Material of hull, superstructures, structural bulkheads, decks and deckhouses
3. Structure of aluminum alloy
4. Machinery spaces of category A
5. Materials of overboard fittings
6. Protection of cargo tank structure against pressure or vacuum in tankers
Bulkheads/Decks in Aluminum

Bulkheads/Decks Class A and Class B

When the bulkheads are built in aluminum, the ratio between the minimum requirements for plate and stiffener dimensioning can be obtained from the requirements for the steel, through the factors of the table:

<table>
<thead>
<tr>
<th>Steel</th>
<th>Aluminum</th>
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<tr>
<td>Plate thickness (t)</td>
<td>1.4 x t</td>
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<tr>
<td>Inertia of the stiffeners (I)</td>
<td>2.8 x I</td>
</tr>
<tr>
<td>Section Modulus of the stiffeners (W)</td>
<td>2.35 x W</td>
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Part D - Escape
Notification of Crew and Passengers

1. Purpose
2. General emergency alarm system
3. Public address systems in passenger ships

Means of Escape

1. Purpose
2. General requirements
3. Means of escape from control stations, accommodation spaces and service spaces
4. Means of escape from machinery spaces
5. Means of escape on passenger ships from special category and open Ro/Ro spaces to which any passengers carried can have access
6. Means of escape from Ro/Ro spaces
7. Additional requirements for Ro/Ro passenger ships
Means of Escape

- The objective is to provide means of escape so that persons onboard can safely and swiftly escape to the lifeboat and liferaft embarkation deck.
- At least 2 widely separated and ready means of escape shall be provided from all spaces or group of spaces.
- Lifts shall not be considered as forming one of the means of escape required.

Means of Escape - General Requirements

- Stairways and ladders shall be arranged to provide ready means of escape to the lifeboat and liferaft embarkation deck from passenger and crew accommodation spaces and from spaces in which the crew is normally employed, other than machinery spaces.
- A corridor, lobby, or part of a corridor from which there is only one route of escape shall be prohibited.
- Dead-end corridors used in service areas which are necessary for the practical utility of the ship, shall be permitted, provided they are separated from crew accommodation areas and are inaccessible from passenger accommodation areas.
- A part of a corridor that has a depth not exceeding its width is considered a recess or local extension and is permitted.
Means of Escape - General Requirements

• All stairways in accommodation and service spaces and control stations shall be of steel frame construction.

• Doors in escape routes shall, in general, open in the direction of escape, except that:
  - Individual cabin doors may open into the cabins in order to avoid injury to persons in the corridor when the door is opened.
  - Doors in vertical emergency escape trunks may open out of the trunk in order to permit the trunk to be used both for escape and for access.

Means of Escape (Passenger Ships)

Main Principles

• Below the bulkhead deck, 2 means of escape, at least 1 of which shall be independent of watertight doors, shall be provided from each watertight compartment or similarly restricted space or group of spaces.

• Above the bulkhead deck, there shall be at least 2 means of escape from each main vertical zone or similarly restricted space or group of spaces at least 1 of which shall give access to a stairway forming a vertical escape (not passing through watertight door).

• At least 1 of the means of escape required shall consist of a readily accessible enclosed stairway, which shall provide continuous fire shelter from the level of its origin to the appropriate lifeboat and liferaft embarkation decks.

• Lifts shall not be considered as forming one of the means of escape required.
Means of Escape (Passenger Ships)

Machinery Spaces

• Shall have 2 separate means of escape composed by steel stairs, as far apart from each other as possible

• One of the stairs shall provide continuous protection against fire, from the lower part of the space up to a safe place, located outside the space.

Corridors

• Dead end corridors shall not have a length greater than

| Ships with more than 36 passengers | 36 m |
| Ships with less than 36 passengers | 7 m  |

Protection of Stairs and Lifts in Floodable/Service Spaces (Passenger Ships)

• Shall be contained in limited spaces by Class A boundaries, with effective means of closure in all the openings, except in the following cases:
  - Stairways connecting only 2 decks does not need to have a trunk if the integrity of the deck is maintained by bulkheads or appropriated doors on one of the decks
  - Stairways may not have casings if they are entirely contained in a given space.

• The stairways shall have direct communication with the corridors. Whenever possible, the stairways shall NOT provide direct access to cabins, lockers or other closed space containing fuels and where a fire can be originated

• All stairways and lift trunks shall be built in way to prevent the flow of smoke and flames from one deck to the other
**Means of Escape (Cargo Ships)**

- The layout of the stairways shall provide the access from all the accommodation areas and from areas where the crew is normally, means of escape to the exposed deck and from there to the life boats
  - At all levels of accommodation there shall be at least 2 widely separated means of escape, for each restricted space or group of spaces
  - Below the lowest open deck, the main escape way will be a stairway and the second escape may be a trunk or a stairway
  - Above the lowest open deck the escape ways shall be stairways or doors to an open deck
  - No dead-end corridors with length > 7 m will be acceptable

**Means of Escape (Cargo Ships)**

- In general, the machinery spaces of category A will always have 2 escape ways:
  - 2 sets of steel stairs as widely apart as possible, leading to doors on the upper zone of the space, from where there is direct access to the exposed deck. In general these stairs shall provide continuous protection against fire
  - 1 steel stair leading to a door on the upper area of the space and, additionally, a steel door on the lower zone of the space, capable of being operated from both sides, and giving access to a direct exit to the deck
Protection of Stair Cases and Lift Trunks Accommodation, Service or Control Station Areas (Cargo Ships)

• Stairways which cross a single deck, shall be protected at least by class B0 boundaries with self-closing doors
• Lifts that cross a single deck, shall be protected at least by class A0 boundaries with steel doors on both levels
• Stairways and lifts that cross more than one deck shall have class A0 boundaries with self-closing doors on every levels

Emergency Escape Breathing Devices

• All ships shall have at least 2 in the accommodation space
• Passenger ships shall have at least 2 in each main vertical zone
• Passenger ships with N > 36 shall have at least 4 in each main vertical zone
Emergency Escape Breathing Device (EEBD)

- A EEBD is a device that supplies air or oxygen, used only to escape from a compartment with a dangerous atmosphere.
- The EEBDs shall not be used to fight the fires, going into tanks or in void space with reduced oxygen, or used by fire fighters. In these situations proper autonomous breathing devices shall be used.
- A EEBD shall
  - Have the minimum service duration of 10 minutes.
  - Have a cover or mask to protect the eyes, nose and mouth during the escape.

Machinery Spaces in Passenger Ships (1)

Escape from spaces below the bulkhead deck
- 2 sets of steel ladders, as widely separated as possible, leading to doors in the upper part of the space similarly separated and from which access is provided to the appropriate lifeboat and liferaft embarkation decks.
  - One of these ladders shall be located within a protected enclosure, from the lower part of the space it serves to a safe position outside the space.
  - Self-closing fire doors of the same fire integrity standards shall be fitted in the enclosure.
  - The ladder shall be fixed in such a way that heat is not transferred into the enclosure through non-insulated fixing points.
  - The protected enclosure shall have minimum internal dimensions of at least 800 mm x 800 mm, and shall have emergency lighting provisions; or
- 1 steel ladder leading to a door in the upper part of the space from which access is provided to the embarkation deck and additionally, in the lower part of the space and in a position well separated from the ladder referred to, a steel door capable of being operated from each side and which provides access to a safe escape route from the lower part of the space to the embarkation deck.
Machinery Spaces in Passenger Ships (2)

Escape from spaces above the bulkhead deck

- 2 means of escape shall be as widely separated as possible and the doors leading from such means of escape shall be in a position from which access is provided to the appropriate lifeboat and liferaft embarkation decks.

- Where such means of escape require the use of ladders, these shall be of steel.
Protection of Vehicle, Special Category and Ro-Ro Spaces

Functional Requirements

- Fire protection systems shall be provided to adequately protect the ship from the fire hazards associated with vehicle, special category and Ro-Ro spaces
- Ignition sources shall be separated from vehicle, special category and Ro-Ro spaces
- Vehicle, special category and Ro-Ro spaces shall be adequately ventilated.

Basic Principles for Passenger Ships

- The main vertical zoning required may not be practicable in vehicle spaces of passenger ships
- Equivalent protection must be obtained in such spaces on the basis of
  - an horizontal zone concept
  - the provision of an efficient fixed fire-extinguishing system.
- An horizontal zone for the purpose of this regulation may include special category spaces on more than one deck provided that the total overall clear height for vehicles does not exceed 10 m.
Fire Extinguishing

• Vehicle spaces and Ro-Ro spaces which are not special category spaces and are capable of being sealed from a location outside of the cargo spaces shall be fitted with a fixed gas fire-extinguishing system, except that:
  - If a CO2 system is fitted,
    • the quantity of gas available shall be at least sufficient to give a minimum volume of free gas equal to 45% of the gross volume of the largest cargo space which is capable of being sealed, and
    • the arrangements shall be such as to ensure that at least 2/3 of the gas required for the relevant space shall be introduced within 10 min
  - Any other fixed inert gas system or fixed high expansion foam system may be fitted provided the Administration is satisfied that an equivalent protection is achieved
  - As an alternative, an approved fixed pressure water spraying system may be fitted.

Free Surface Concerns

• When fixed pressure water-spraying systems are provided, large quantities of water can accumulate on the deck(s) during the operation of the water-spraying system
• Serious loss of stability could arise
• Specific arrangements are specified for passenger and cargo ships
Ro/Ro Spaces - Passenger Ships (1)

- **Above the bulkhead deck**, scuppers shall be fitted so as to ensure that such water is rapidly discharged directly overboard.
- Discharge valves for scuppers, fitted with positive means of closing operable from a position above the bulkhead deck, shall be kept open while the ships are at sea.

Ro/Ro Spaces - Passenger Ships (2)

- **Below the bulkhead deck**, the Administration may require additional pumping and drainage facilities to be provided.
- In such case, the drainage system shall be sized to remove no less than 125% of the combined capacity of both the water spraying system pumps and the required number of fire hose nozzles.
- The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls.
- **Bilge wells** shall be of sufficient holding capacity and shall be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment.
Ro/Ro Spaces - Cargo Ships

- The drainage system shall be sized to remove no less than 125% of the combined capacity of both the water spraying system pumps and the required number of fire hose nozzles.
- The drainage system valves shall be operable from outside the protected space at a position in the vicinity of the extinguishing system controls.
- Bilge wells shall be of sufficient holding capacity and shall be arranged at the side shell of the ship at a distance from each other of not more than 40 m in each watertight compartment.
- If this is not possible the adverse effect upon stability of the added weight and free surface of water shall be taken into account to the extent deemed necessary by the Administration.

Fire Protection in Ro/Ro Spaces

- Portable extinguishers shall be provided at each deck level in each hold or compartment where vehicles are carried, spaced not more than 20 m apart on both sides of the space.
- At least one portable fire extinguisher shall be located at each access to such a cargo space.
- Additionally, vehicle, Ro-Ro and special category spaces intended for the carriage of motor vehicles with fuel in their tanks for their own propulsion shall be provided with:
  - At least 3 water fog applicators
  - 1 portable foam applicator unit, provided that at least two such units are available in the ship for use in such ro-ro spaces.

Ventilation System

- Enclosed garage spaces shall have ventilation system guaranteeing 6 renew/hour, based on the empty volume.
Fire Control Plans

- On ships with more than 36 passengers, the following information must be available in the Fire Control Plan [A.756 (18)]:
  - Ship's keel-laying date and application of the SOLAS Conventions and amendments. Original method (I, II, III or with or without sprinklers, etc.) of fire safety construction, as applicable
  - Which additional fire safety measures were applied, if any
  - Dates and descriptions of any modifications to the ship, which in any way alter its fire safety

Symbols in Fire Plans

- The symbols on the Fire Control Plan must be in accordance to the A.952 (23) - “Graphical Symbols for Shipboard Fire Control Plans”, adopted on 5 December 2003
Additional References

✓ A.756 (18) - Guidelines on the information to be provided with Fire Control Plans and booklets required by SOLAS regulations II-2/20 and 41-2 (CD-ROM#64)
✓ A.757 (18) - Standards for the Calculation of the Width of Stairways Forming Means of Escape on Passenger Ships (CD-ROM#64)
✓ A.952 (23) - “Graphical Symbols for Shipboard Fire Control Plans” (CD-ROM#64)

Links

- www.imo.org/InfoResource/ (IMO Resolutions repository)