# FIRE SAFETY ON SHIPS

## A PRACTICAL GUIDE FOR SEAFARERS

MARINE INSIGHT

# Fire Safety on Ships

*A Practical Guide for Seafarers*

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*"Fire Safety on Ships: A Practical Guide for Seafarers"*

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# PREFACE

Fire does not wait for a convenient moment.

It does not announce itself during daylight hours when the full crew is awake and the Master is on the bridge. It starts at 0300, in an unmanned space, on a vessel three days from the nearest port. It starts small — a dripping fuel line, an overloaded cable, an unattended galley — and within minutes it becomes the most serious emergency a ship and her crew will ever face.

I have spent years working in the maritime industry, and one truth about fire safety at sea has always stood out clearly: the gap between knowing and doing is where disasters happen. Seafarers attend fire drills. They read the muster list. They know where the extinguisher is. But genuine understanding — of how fire behaves on a ship, why the systems exist, what to do in the first sixty seconds — is far less common than it should be.

This guide was written to close that gap.

It is not a regulatory manual or an examination textbook. It is a practical introduction to fire safety on ships — written for every rank, every department, and every person with a genuine interest in understanding how ships manage one of their most serious risks. Whether you are a cadet preparing for your first vessel, an experienced officer refreshing your knowledge, a shore-based superintendent overseeing fleet safety, or simply someone who wants to understand how maritime fire safety works — this guide is written for you.

The chapters cover everything from the science of how fire behaves in an enclosed steel environment, to the SOLAS regulations that govern safety equipment, the detection and fixed suppression systems fitted on modern vessels, the procedures followed during a real emergency, and the daily prevention habits that stop fires from starting in the first place.

Fire safety is not a topic you master once and set aside. It is knowledge that belongs on every watch, in every space, on every ship.

I hope this guide serves you well — and that you never need most of what it contains.

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## Chapter One

# UNDERSTANDING FIRE ON SHIPS: WHY IT IS DIFFERENT

Fire is one of the most feared emergencies at sea.

On land, a fire can be serious. On a ship, it can be catastrophic. There is no fire brigade to call. No escape route that leads to open ground. The vessel itself — steel, machinery, fuel, and cargo — can become the fuel that feeds the flames.

Every person on board, from the Master to the newest crew member, has a role to play when fire breaks out. And more importantly, every person has a role to play in making sure it never does.

## Why Fire Behaves Differently at Sea

On a ship, fire does not behave the way it does in a building. Several factors make it more dangerous and more unpredictable.

A ship is a confined, enclosed environment. Smoke fills corridors and accommodation spaces within minutes. Ventilation systems — designed to circulate fresh air — can carry smoke and heat to parts of the ship far from the original source. What starts as a small engine room fire can become a vessel-wide emergency faster than most people expect.

Ships carry large quantities of fuel oil, lubricating oil, and in many cases, flammable cargo. A fire that reaches a fuel source does not stay small for long. The structural steel of the ship conducts heat, spreading temperature rises to adjacent spaces even before flames arrive.

There is also the question of stability. Firefighting water accumulates on deck and in flooded compartments. If not controlled, this free surface effect can threaten the vessel's stability — meaning a fire can indirectly cause a ship to capsize even after the flames are brought under control.

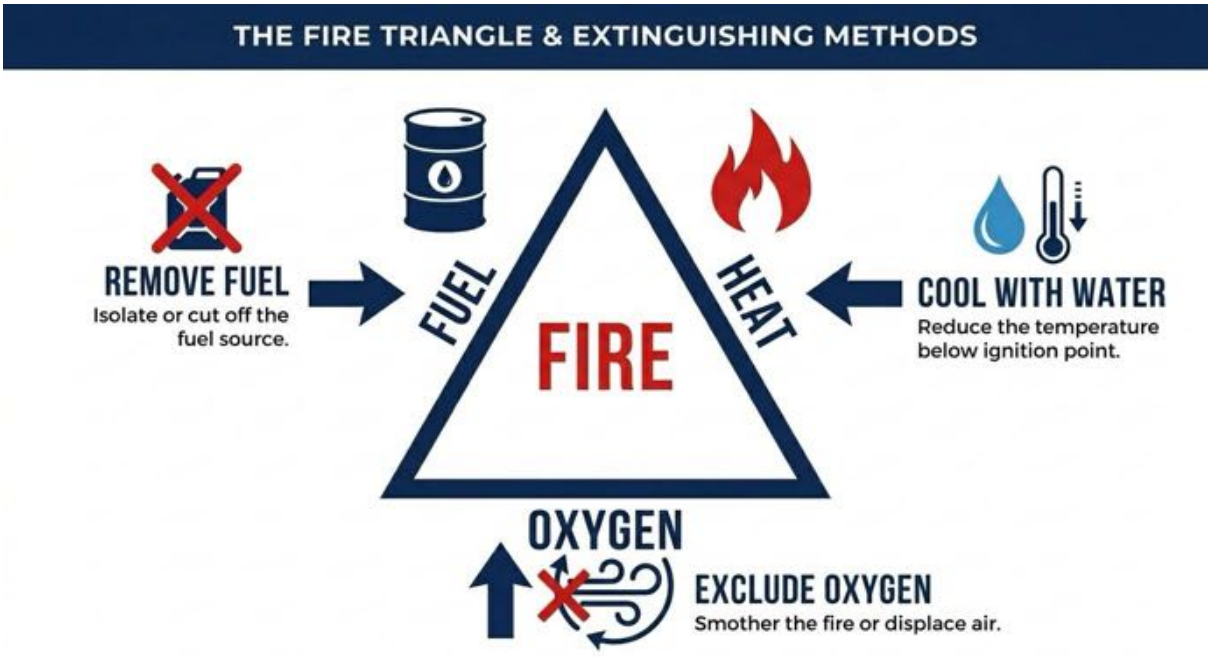
## The Three Elements of Fire

Fire needs three things to exist: fuel, heat, and oxygen. Remove any one of them and the fire dies.

This principle — known as the fire triangle — is the foundation of every firefighting strategy used on ships.

Understanding this is not just theory. It directly determines which extinguishing agent you reach for, which fixed system activates, and what actions the crew takes in the first critical minutes of an emergency.

- Fuel — anything that burns: oil, wood, paint, rope, canvas, cargo, gas
- Heat — the ignition source or the sustained temperature that keeps combustion going
- Oxygen — supplied by the surrounding air or by the ship's ventilation system




## Classes of Fire on Ships

Not all fires are the same, and using the wrong extinguishing agent can make a fire worse — or create a new danger entirely. Ships carry multiple types of fire risk, and seafarers need to recognise them instantly.

- Class A — Solid materials: wood, rope, fabric, paper
- Class B — Flammable liquids: fuel oil, diesel, paint, solvents
- Class C — Flammable gases: LPG, acetylene, natural gas
- Class D — Flammable metals: rare on merchant ships but present in some cargo types
- Class E — Electrical fires: switchboards, machinery, galley equipment
- Class F — Cooking oils and fats: galley fires, deep fryers

Each class requires a specific response. A $CO_2$ system that works perfectly on a Class B fuel fire is useless — and potentially dangerous — on a Class A fire in the accommodation. Knowing the difference is not optional knowledge. It is basic seamanship.

### Example — Engine Room Fire on a Product Tanker

A product tanker is underway in the Indian Ocean. At 0300, the engine room alarm activates. The duty engineer discovers a fuel oil leak from a high-pressure line has sprayed onto a hot exhaust manifold and ignited.

- The engineer immediately activates the engine room fire alarm
- Exits the engine room and closes the watertight fire door behind him
- Notifies the bridge

- The Officer of the Watch sounds the general alarm, stops ventilation to the engine room, and prepares to release the fixed $CO_2$ system on the Master's order
- The Master, confirming the engine room is evacuated, authorises $CO_2$ release

The system floods the space, removing oxygen and extinguishing the fire within minutes. This incident followed the correct procedure exactly.

The fire was contained because the crew knew their roles, the detection system worked, and no one attempted to fight the fire with a portable extinguisher in a space already beyond manual control.


## What This Guide Will Help You Do

Fire safety on ships is not just about knowing where the extinguisher is. It is about understanding how fires start, how they spread, what systems exist to detect and fight them, and what your specific role is when the alarm sounds.

Whether you are a cadet joining your first vessel, an experienced officer refreshing your knowledge, a shore-based superintendent overseeing fleet safety, or simply someone with an interest in how ships manage one of their greatest risks — this guide gives you a clear, practical foundation.

## Chapter Two

# SOLAS REQUIREMENTS FOR FIRE SAFETY

Every ship trading internationally operates under one foundational rulebook — SOLAS.

The International Convention for the Safety of Life at Sea, known universally as SOLAS, is the IMO convention that sets the minimum safety standards for merchant vessels worldwide.

First adopted in 1914 following the Titanic disaster, it has been updated continuously ever since. When it comes to fire safety, SOLAS Chapter II-2 is the section every seafarer and maritime professional needs to understand.

It does not make recommendations. It sets mandatory requirements.


## What SOLAS Chapter II-2 Covers

SOLAS Chapter II-2 is dedicated entirely to fire protection, detection, and extinction on ships. It applies to all vessel types — tankers, bulk carriers, container ships, passenger vessels, and general cargo ships — though specific requirements vary by vessel type and size.

The chapter is built around three core principles:

- Fire prevention — reducing the chance of fire starting in the first place
- Fire detection and alarm — ensuring fires are identified early before they spread
- Fire suppression — providing the means to fight and extinguish fires effectively

Everything in a ship's fire safety setup — the detectors, the extinguishers, the fixed systems, the fire doors, the drills — exists because SOLAS requires it.

## Key SOLAS Fire Safety Requirements

### 1. Structural Fire Protection

SOLAS requires ships to be built with fire-resistant materials and structural divisions that slow the spread of fire between spaces. These are classified as:

- A-class divisions — steel bulkheads and decks that prevent fire and smoke passage for 60 minutes (A-60), 30 minutes (A-30), 15 minutes (A-15), or 0 minutes (A-0)
- B-class divisions — lighter divisions that resist fire for 30 minutes (B-30) or 15 minutes (B-15)
- C-class divisions — non-fire-resistant divisions used only where regulations permit

The classification of spaces — engine room, accommodation, cargo areas, control stations — determines which division standard applies between them.

### 2. Fire Detection and Alarm Systems

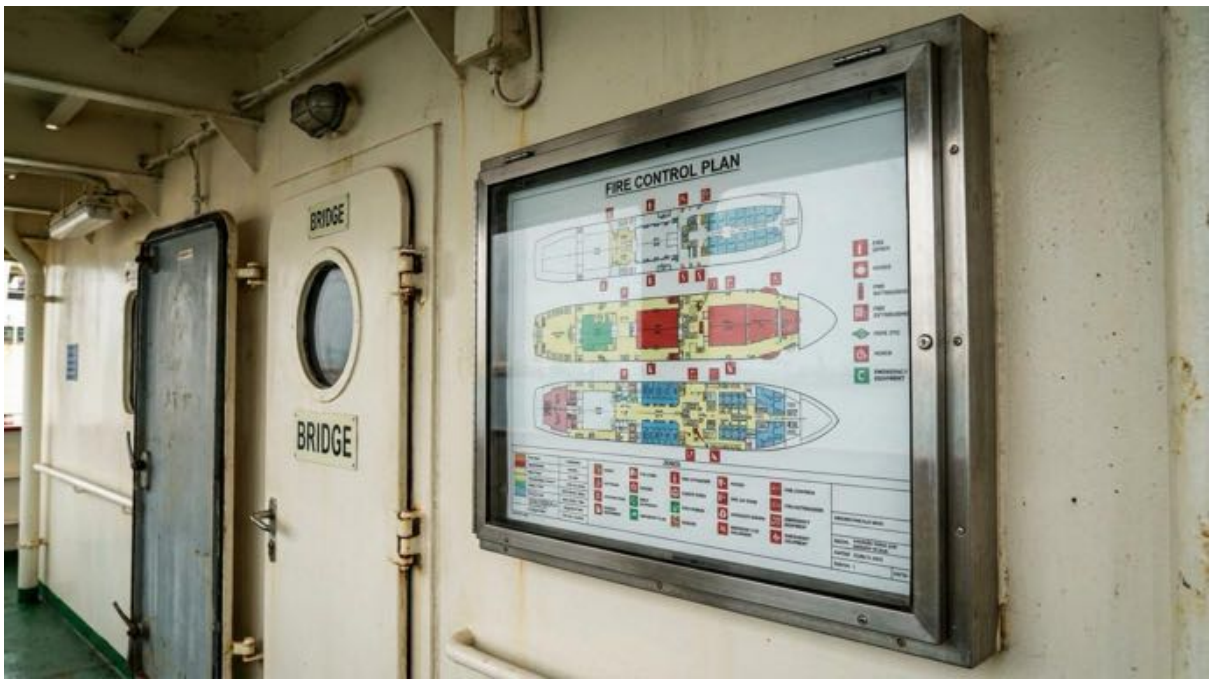
SOLAS mandates that all ships carry fixed fire detection and alarm systems covering all enclosed spaces. These systems must be capable of automatically detecting fire or smoke, triggering audible and visual alarms at the bridge and fire control station, and identifying the specific zone where the detection occurred.

The bridge must be able to identify exactly where on the ship the alarm has activated — not just that a fire exists somewhere.

### 3. Fire Extinguishing Systems

SOLAS prescribes specific firefighting equipment based on vessel type and space:

- Portable fire extinguishers in all accessible areas
- Fixed fire smothering systems in engine rooms and pump rooms
- Deck foam systems on tankers
- Sprinkler systems in passenger ship accommodation
- Water mist systems in machinery spaces on certain vessel types




## 4. Fire Control Plans

Every SOLAS vessel must carry fire control plans — detailed diagrams showing the layout of every deck, the location of all fire detection systems, firefighting equipment, escape routes, and fixed systems. These plans must be permanently displayed in weathertight enclosures outside the deckhouse, available to shore-based firefighters responding to an emergency, and updated whenever the ship undergoes structural changes.

Shore authorities arriving at a stricken vessel rely on these plans. They are not a formality — they are a critical emergency tool.

## 5. Fire Drills

SOLAS requires fire drills to be conducted at regular intervals — at minimum once a month on most vessel types. Every crew member must know their fire station, their duties, and how to operate the equipment assigned to them before the vessel leaves port.

### Example — Port State Control Deficiency — Fire Safety Violations

A bulk carrier arrives at Rotterdam for a routine Port State Control inspection. The PSC officer conducts a fire safety check and finds:

- Two portable fire extinguishers in the engine room with expired service dates
- A fire damper in the main ventilation trunk stuck in the open position
- No updated fire control plan reflecting recent accommodation modifications
- One smoke detector in the officers' mess disconnected and not reported

The vessel is issued four deficiencies. The Master is given 24 hours to rectify the extinguisher and detector issues before departure. The damper and plan deficiencies require written confirmation from the company before the ship is cleared.

Fire safety deficiencies consistently appear among the top PSC detention causes globally. The cost of non-compliance — in delays, port fees, reputational damage, and potential detention — far exceeds the cost of maintaining equipment correctly.

## SOLAS and You

Whether you are an officer responsible for maintaining fire safety records, a rating whose drill station is the fire pump, or a shore superintendent auditing vessel compliance — SOLAS Chapter II-2 is the standard everything is measured against.

Understanding it does not require a legal background. It requires knowing what is mandatory, what is inspected, and what happens when requirements are not met. The chapters ahead build on this foundation — covering each system and procedure that SOLAS requires in practical, operational detail.

## Chapter Three

# FIRE DETECTION AND ALARM SYSTEMS ON SHIPS

A fire detected in its first two minutes can be controlled. A fire detected after ten minutes can destroy a ship.

The difference between those two outcomes is almost always the detection system. On a modern merchant vessel, fire detection is not left to chance or to someone happening to smell smoke. It is a continuously active, automated system monitoring every enclosed space on board — engine room, accommodation, cargo holds, store rooms, and control stations — around the clock.

Understanding how these systems work is not just for officers. Every person on board needs to know what the alarm means, where it is coming from, and what to do in the first sixty seconds after it activates.

## How Ship Fire Detection Systems Work

A ship's fixed fire detection and alarm system operates on a simple principle — sensors placed throughout the vessel continuously monitor for signs of fire and report back to a central control panel, usually located on the bridge or at a dedicated fire control station.

When a sensor detects smoke, heat, or flame beyond a set threshold, it triggers an alarm at the control panel identifying the exact zone where the detection occurred. Audible alarms sound throughout the ship simultaneously. The officer on watch knows within seconds not just that there is a fire, but where it is.

Modern systems are zoned — the ship is divided into numbered detection zones, each covering a group of spaces. When an alarm activates, the zone number identifies the

area immediately, allowing the crew to respond to the right location without confusion.

## Types of Fire Detectors Used on Ships

Different spaces on a ship present different fire risks. No single detector type works optimally in every environment, which is why ships use a combination of detector technologies.

### 1. Smoke Detectors

The most common type on ships. They work by detecting particles of combustion in the air — either through ionisation or optical sensing.

- Ionisation detectors — sensitive to fast-flaming fires that produce small smoke particles
- Optical detectors — sensitive to slow smouldering fires that produce larger visible smoke particles
- Best suited for: accommodation spaces, corridors, store rooms, control stations

### 2. Heat Detectors

Respond to a rise in ambient temperature rather than smoke. Two main types:

- Fixed temperature detectors — activate when temperature exceeds a set point, typically 54 degrees Celsius or higher
- Rate-of-rise detectors — activate when temperature rises faster than a set rate per minute, regardless of the actual temperature reached
- Best suited for: galleys, laundries, engine rooms where smoke or steam is normally present

### 3. Flame Detectors

Detect the infrared or ultraviolet radiation emitted by an open flame. Respond extremely fast — within seconds of flame appearance. Best suited for engine rooms, pump rooms, and cargo areas on tankers. Not suitable for spaces with normal sources of UV or IR radiation.

### 4. Smoke Sampling Systems (Aspirating Systems)

Instead of waiting for smoke to reach a detector, these systems actively draw air samples from protected spaces through a network of pipes and analyse them at a central unit. They detect fire at a much earlier stage than conventional point detectors — sometimes at the pre-combustion stage before visible smoke appears. Best suited for cargo holds, unmanned machinery spaces, and high-risk areas.

## The Fire Alarm Control Panel

The fire alarm control panel is the nerve centre of the entire detection system. On most vessels it is located on the bridge, with a repeater panel at the fire control station.

The panel continuously displays the status of every zone. When an alarm activates it shows the zone number and description, the type of alarm, the time of activation, and whether the alarm has been acknowledged. The officer on watch must acknowledge the alarm, identify the zone, and initiate the ship's fire response procedure immediately.

## Manual Call Points

Alongside automatic detectors, ships are fitted with manual call points — red break-glass units mounted at regular intervals along corridors and escape routes. Any crew member who discovers a fire can activate the alarm manually by breaking the glass panel. Manual call points ensure that even if a fire starts in a space with no automatic detector coverage, or if a detector fails, the alarm can still be raised instantly by anyone on board.

## Common Causes of False Alarms

False alarms are a genuine operational problem on ships. They cause alarm fatigue — crew members begin to assume activations are false, delaying response to a real fire.

Common causes include:

- Steam or cooking fumes reaching smoke detectors
- Dusty or dirty detector heads in poorly maintained spaces
- Insects entering detector housings
- Detector heads too close to galley exhaust outlets

- Vibration causing loose connections in the detection circuit

Reducing false alarms requires regular detector cleaning, correct detector placement, and prompt investigation of every activation — even when the cause seems obvious.

### Example — Smoke Detector Activation — Bulk Carrier, South China Sea

At 0215, the bridge alarm panel on a Handymax bulk carrier activates showing Zone 7 — Forward Accommodation, Deck C. The Officer of the Watch acknowledges the alarm and calls the bosun's cabin, which is in Zone 7. The bosun investigates and finds a crew member smoking in his cabin with the door closed. No fire. The OOW logs the false alarm.

Three weeks later, at 0340, the same zone activates again. This time the bosun finds a smouldering mattress — the crew member fell asleep with a cigarette. The fire is caught at the smouldering stage, extinguished with a portable CO2 extinguisher before it develops.

The detection system worked exactly as designed. The mattress fire, caught within minutes of ignition, never had the chance to spread to the corridor or adjacent cabins.


## Testing and Maintenance

SOLAS requires fire detection systems to be tested and maintained at regular intervals:

- Weekly testing of the alarm panel and audible alarms
- Monthly testing of individual detector heads by zone
- Annual inspection and servicing by a certified technician

- Immediate reporting and replacement of any faulty detector

A detection system that has not been tested is a detection system that cannot be trusted. Maintenance is not paperwork — it is the difference between a system that works at 0340 and one that does not.

## Chapter Four

# TYPES OF FIRE AND THE RIGHT EXTINGUISHING AGENTS

Using the wrong extinguishing agent on a fire does not just fail to put it out — it can make the situation dramatically worse.

Water on a burning oil fire spreads flaming liquid across the deck. $CO_2$ in an unventilated space can kill the crew member fighting the fire before it kills the fire. Foam on an electrical fire can conduct current back to the person holding the hose. These are not theoretical risks. They are the reason every seafarer needs to know fire classification before they ever touch an extinguisher.

Fire on ships is categorised by what is burning. The category determines the extinguishing agent. There are no exceptions to this rule.

## The Six Classes of Fire

### Class A — Ordinary Combustible Materials

Class A fires involve solid materials that burn and leave ash or char. Common sources include bedding, mattresses, and clothing in cabins; wooden dunnage and packing materials in cargo holds; rope, mooring lines, and canvas covers on deck; and paper, cardboard, and waste materials in store rooms.

The best extinguishing agent for Class A fires is water. Water cools the burning material below its ignition temperature and soaks into the fuel, preventing re-ignition.

### Class B — Flammable Liquids

Class B fires involve liquids that burn — fuel oil, diesel, lubricating oil, paint, solvents, and hydraulic fluid. These are among the most dangerous fires on ships because fuel sources are present in large quantities throughout the vessel.

Never use water on a Class B fire. Water does not mix with oil — it causes the burning liquid to splash and spread, rapidly enlarging the fire area. The correct agents are:

- Foam — smothers the surface, cutting off oxygen and cooling the fuel
- $CO_2$ — displaces oxygen in the immediate area
- Dry powder — rapid knockdown of flames, though limited cooling effect

### Class C — Flammable Gases

Class C fires involve burning gases — LPG, acetylene used in welding operations, or natural gas on LNG carriers. The correct response is almost always to shut off the gas supply first, then deal with any remaining fire. Dry powder can be used to knock down flames if immediate gas isolation is not possible. Water is ineffective on gas fires.

### Class D — Flammable Metals

Class D fires involve combustible metals — magnesium, titanium, sodium, and similar materials. These are rare on most merchant ships but can occur in certain cargo types. Standard extinguishing agents — water, foam, $CO_2$ — are ineffective and can react dangerously with burning metals. Specialist dry powder agents designed specifically for Class D fires are required.

### Class E — Electrical Fires

Class E fires involve energised electrical equipment. Never use water or foam on an electrical fire while the equipment remains energised. The correct approach:

- Isolate the electrical supply to the affected equipment immediately if safe to do so
- Once de-energised, treat as a Class A or B fire depending on what is burning
- If isolation is not possible, use $CO_2$ or dry powder — both are non-conductive

$CO_2$ is the preferred agent for electrical fires because it leaves no residue and does not damage sensitive equipment.

### Class F — Cooking Oils and Fats

Class F fires involve hot cooking oils and fats in galley equipment. Never use water on a Class F fire. Cold water hitting burning oil at high temperature causes an explosive steam reaction that launches a fireball of burning oil across the galley. The correct agents are:

- Wet chemical extinguishers — react with hot oil to form a soapy foam blanket sealing the surface
- A fire blanket — effective for smaller pan fires by cutting off oxygen

Every ship's galley must carry a wet chemical extinguisher and a fire blanket within immediate reach of cooking equipment.


## Quick Reference — Fire Classes and Agents

Knowing this by memory is basic seamanship. Every crew member should be able to recall it without hesitation:

- Class A (Solids) — Use: water, foam. Never use: nothing specific
- Class B (Flammable liquids) — Use: foam, $CO_2$, dry powder. Never use: water
- Class C (Flammable gases) — Use: shut off supply, dry powder. Never use: water
- Class D (Flammable metals) — Use: specialist dry powder. Never use: water, $CO_2$, foam

- Class E (Electrical) — Use: $CO_2$, dry powder. Never use: water, foam
- Class F (Cooking oils) — Use: wet chemical, fire blanket. Never use: water

### Example — Wrong Agent, Wrong Outcome — Galley Fire on a Container Ship

A container ship is three days out of Singapore. A rating on galley duty notices flames rising from the deep fryer. Panicking, he grabs the nearest extinguisher — a water type mounted just outside the galley door — and discharges it directly into the burning oil.

The result is immediate and violent. The cold water hitting the superheated oil causes an explosive vaporisation. A fireball erupts across the galley ceiling. The rating suffers burns to his face and arms. The fire, now spread across a much larger area, requires the fixed galley suppression system to activate before it is brought under control.

The water extinguisher outside the galley door should never have been there. Equipment placement, crew training, and knowing which agent to use before the fire starts — these three things together determine the outcome.

Chapter Five

# PORTABLE FIRE EXTINGUISHERS: SELECTION AND USE

A portable fire extinguisher is the first line of defence against a fire that is still small enough to fight.

The window for using one is narrow. A fire in its early stages — a burning waste bin, a smouldering cable, a small fuel spillage that has ignited — can be knocked down in seconds with the right extinguisher. The same fire left for two minutes becomes a fight that requires hoses, breathing apparatus, and a full crew response.

But only if the right one is selected, and only if the person using it knows what they are doing.


## Types of Portable Extinguishers Carried on Ships

### Water Extinguishers

- Suitable for: Class A fires only
- How it works: discharges a jet or spray of water that cools the burning material below ignition temperature
- Capacity on ships: typically 9 litres
- Never use on: Class B, C, D, E, or F fires

### Foam Extinguishers

- Suitable for: Class A and Class B fires
- How it works: discharges a blanket of foam that seals the fuel surface, cutting off oxygen and cooling simultaneously

- Capacity on ships: typically 9 litres
- Never use on: electrical fires or Class C gas fires

### CO2 Extinguishers

- Suitable for: Class B and Class E fires
- How it works: discharges carbon dioxide gas that displaces oxygen in the immediate fire area
- Critical safety point: never use in a confined or unventilated space without breathing apparatus
- Capacity on ships: typically 2kg or 5kg

### Dry Powder Extinguishers

- Suitable for: Class B, C, and D fires
- How it works: discharges a cloud of fine powder that chemically interrupts the combustion reaction
- Limitation: significant residue damage, limited cooling effect, fire can re-ignite
- Capacity on ships: typically 6kg or 9kg

### Wet Chemical Extinguishers

- Suitable for: Class F fires exclusively
- How it works: discharges a fine mist of potassium-based solution that forms a soapy foam crust on burning oil
- Mandatory location: ship's galley within immediate reach of cooking equipment
- Never use on: any other fire class

## How to Use a Portable Fire Extinguisher — The PASS Technique

Regardless of extinguisher type, the operating method follows the same four-step sequence known as **PASS.**

Every seafarer should be able to execute this under stress, in poor visibility, and while wearing gloves.

- **P** — Pull the safety pin from the handle, breaking the tamper seal and unlocking the operating lever
- **A** — Aim the nozzle or horn at the base of the fire — not at the flames
- **S** — Squeeze the operating lever firmly and steadily to open the valve and discharge the agent
- **S** — Sweep the nozzle from side to side across the base of the fire, working from the near edge toward the back

After discharge, do not turn your back on the fire immediately. Watch for re-ignition for at least thirty seconds. If the fire re-ignites and the extinguisher is empty, evacuate the space, close the door, and raise the alarm if not already done.

## Safe Operating Distance

Each extinguisher type has an effective range:

- Water and foam: 3–5 metres
- $CO_2$: 1–2 metres — must be used at close range
- Dry powder: 4–6 metres
- Wet chemical: 1–1.5 metres — always use the extended applicator lance

$CO_2$ extinguishers require the user to get closer to the fire than any other type. This makes correct protective equipment and situational awareness critical when deploying one.

## Inspection and Maintenance Requirements

SOLAS and flag state requirements mandate:

- Monthly visual inspection — check pressure gauge is in the green zone, safety pin is intact, no visible damage or corrosion
- Annual inspection and weighing — $CO_2$ extinguishers lose charge over time even without discharge
- Five-yearly hydraulic pressure testing of the cylinder body
- Immediate replacement or recharge after any discharge — even partial

An extinguisher with an expired inspection date is a PSC deficiency waiting to happen.

## Knowing When NOT to Fight

A portable extinguisher has one job — to attack a fire in its very early stage. Do not attempt to fight a fire with a portable extinguisher if:

- The fire has spread beyond the immediate point of origin
- Smoke is already filling the space
- You do not have a clear escape route behind you
- You are not sure what is burning
- The fire involves the ship's structure or insulation materials

In any of these situations the correct action is to leave the space, close all doors and hatches behind you, raise the alarm, and muster at your fire station.

### Example — Correct First Attack — Engine Room Bilge Fire on a General Cargo Ship

A motorman carrying out routine rounds in the engine room notices a small fire in the bilge area beneath the purifier flat. Oily rags left near a leaking fuel connection have ignited. The fire is approximately the size of a waste bin — small, localised, and not yet spreading.

He grabs the nearest foam extinguisher from its bracket, pulls the pin, aims at the base of the flames, and sweeps steadily across the burning rags.

The fire is out in under twenty seconds. He immediately notifies the duty engineer, who identifies and repairs the leaking fuel connection. The incident is logged and reported to the Chief Engineer.

The fire never reached the size where it needed anything more than one extinguisher and one alert crew member. That is exactly how first-attack firefighting is supposed to work.

## Chapter Six

# FIXED FIREFIGHTING SYSTEMS ON SHIPS

Portable extinguishers handle small fires. Fixed systems handle everything else.

When a fire grows beyond what a crew member with an extinguisher can manage — or when it breaks out in a space too dangerous to enter — the ship's fixed firefighting systems become the primary means of suppression. These are permanently installed, purpose-built systems designed to flood, smother, or cool a fire in a specific space automatically or on command.

Understanding what these systems are, where they protect, and how they activate is essential knowledge for every person on board — not just engineers and officers.

## CO2 Total Flooding Systems

The CO2 total flooding system is the most common fixed firefighting system found in engine rooms and cargo pump rooms on merchant vessels worldwide. When activated, the system releases a calculated volume of carbon dioxide gas into the protected space, rapidly reducing the oxygen concentration below the level needed to sustain combustion — approximately 15% or below.

The system consists of:

- A bank of high-pressure CO2 cylinders stored in a dedicated CO2 room
- A distribution manifold and piping network leading to the protected space
- Fixed nozzles positioned throughout the space for even gas distribution
- A control panel with manual release handles and alarm indicators
- Pre-discharge alarms — both audible and visual — that activate before gas release

Critical safety requirement: the protected space must be fully evacuated and all ventilation openings closed before $CO_2$ is released. $CO_2$ is lethal to humans in the concentrations required to extinguish a fire. The pre-discharge alarm exists to give crew members time to escape — it is not a warning that gas has already been released.

The sequence for $CO_2$ system activation is always: confirm space is evacuated, stop all ventilation, close all fire dampers, activate the system, then account for all personnel immediately after release.


## High-Pressure Water Mist Systems

Water mist systems discharge extremely fine droplets of water at high pressure into a protected space. The tiny droplets vaporise rapidly on contact with heat, absorbing enormous amounts of energy and reducing the temperature of the fire and surrounding gases very quickly.

Unlike traditional water spray, water mist uses significantly less water — reducing the risk of flooding and stability problems. It is effective against Class A and Class B fires and is increasingly used in machinery spaces on newer vessels, accommodation areas, and galleys.

## Foam Systems — Deck and Machinery Space

Foam fixed systems are mandatory on oil tankers and are found in engine rooms and cargo pump rooms on many vessel types.

Two main types are found on ships:

- **High-expansion foam systems** — produce large volumes of low-density foam that fills a space rapidly, suitable for engine rooms and enclosed spaces
- **Low-expansion foam systems** — produce a denser, more stable foam blanket, used on tanker decks and in pump rooms for liquid fuel fires

Tankers are required under SOLAS to carry a fixed foam system capable of covering the entire cargo deck area, with foam monitors positioned to reach all parts of the deck without crew needing to enter a danger zone.

## Sprinkler Systems

Automatic sprinkler systems are mandatory in accommodation spaces on passenger ships and on some ro-ro and cargo vessel types. Individual sprinkler heads activate independently when the temperature in their immediate area reaches a set threshold — typically between 68 and 93 degrees Celsius — melting a heat-sensitive glass bulb and releasing water directly onto the fire below.

Unlike total flooding systems, sprinklers activate only in the affected area. A fire in one cabin activates only the sprinkler heads in that cabin — not throughout the entire accommodation block.

## Local Application Systems

Some high-risk equipment items carry their own dedicated fixed suppression systems. Common examples include:

- Deep fryer suppression systems in galleys — wet chemical, automatically activated by heat
- Paint locker $CO_2$ or inert gas systems
- Incinerator room fixed systems
- Purifier and separator local protection on some vessels

### Example — $CO_2$ System Activation — Bulk Carrier Engine Room Fire

A Panamax bulk carrier is at anchor when the engine room fire detection panel activates showing multiple zones. The duty engineer enters the engine room, encounters heavy smoke from the generator flat, exits, closes the watertight door, and reports to the bridge.

The Master confirms all engine room personnel are accounted for. He orders ventilation stopped, fire dampers closed, and $CO_2$ released. Post-incident inspection reveals a fuel oil leak from a generator injector line had sprayed onto the exhaust manifold and spread to insulation lagging.

Without the $CO_2$ system, the fire would have been uncontrollable from outside the space. The vessel required external assistance to restore propulsion, but no crew were injured and the ship was not lost. The system worked exactly as designed.

## Chapter Seven

# FIRE DAMPERS, DOORS, AND PASSIVE FIRE PROTECTION

Active firefighting — extinguishers, hoses, fixed systems — gets most of the attention. But the systems that stop fire from spreading in the first place save just as many lives.

Passive fire protection is built into the ship itself. It does not need to be activated, operated, or maintained the same way active systems do. It works by containing fire within a defined area — buying time for crew to respond, for fixed systems to activate, and for passengers and crew to escape.

Understanding passive protection means understanding that fighting a fire and containing a fire are two different things — and that containment often matters more.


### Structural Divisions — A, B, and C Class

SOLAS requires ships to be divided into fire zones by structural divisions classified according to their fire resistance. The boundary between the engine room and the accommodation, between the cargo hold and the machinery space, between the galley and the corridor — all must meet specific fire resistance standards.

A-60 divisions — the highest standard — must maintain structural integrity and prevent the passage of smoke and flame for sixty minutes when one side is exposed to a standard fire test. This gives crew sixty minutes to fight the fire or evacuate before structural failure allows it to spread.

### Fire Doors

Fire doors are the weak points in structural divisions — necessary for access but potentially compromising the integrity of the fire boundary if left open. SOLAS requires fire doors to be:

- Self-closing — equipped with hydraulic or spring-loaded closing mechanisms
- Capable of being released remotely from the bridge fire control panel
- Maintained free of obstructions — wedging a fire door open is a serious safety violation
- Fitted with intumescent seals that expand when heated, sealing gaps around the door frame

The single most common passive fire protection violation found during PSC inspections and ship audits is fire doors wedged or propped open. A fire door held open with a fire extinguisher — an image that should be absurd but is found regularly — provides zero fire containment.

## Fire Dampers

Ventilation systems are essential for habitability and machinery cooling but represent a direct pathway for fire and smoke to travel between spaces. Fire dampers are installed in ventilation ducts where they pass through fire-rated structural divisions.

When heat or smoke is detected, dampers close automatically — sealing the duct and preventing fire and smoke from passing through to adjacent spaces. They can also be closed manually from the bridge or fire control station.

- Tested at regular intervals to confirm they close fully and freely
- Inspected for corrosion, paint buildup, or physical damage that could prevent closure
- Logged in the maintenance record

A damper that cannot close fully negates the fire rating of the division it is installed in.


## Escape Routes and Emergency Escape Breathing Devices

SOLAS requires every space on board to have at least two means of escape leading to the open deck or a safe area. Escape routes must be clearly marked with photoluminescent signage that remains visible in smoke and darkness, free of obstructions at all times, wide enough for crew in full firefighting gear to pass, and fitted with low-level lighting that activates on emergency power.

Emergency Escape Breathing Devices — EEBDs — are compact hood-type units that provide approximately ten minutes of breathable air, enough for a person to escape through a smoke-filled corridor to fresh air. They are not firefighting equipment and must never be used to enter a fire zone. They are escape tools only.

## Insulation and Surface Finishes

The materials used to line accommodation spaces, corridors, and ceilings are regulated under SOLAS to limit how quickly fire spreads across surfaces. Paints, varnishes, and decorative finishes must meet specified flame spread ratings. Unauthorised repainting with non-approved materials can significantly increase fire spread rates.

### Example — Fire Door Failure — Passenger Ferry Accommodation Fire

A passenger ferry operating a night crossing experiences a fire in a cabin on Deck 5 originating from an overloaded electrical socket. The automatic sprinkler activates and controls the fire within the cabin.

However, the fire door to the cabin corridor had been propped open with a chair by a passenger wanting ventilation. Smoke from the cabin spread into the corridor before the door could be released remotely, affecting four adjacent cabins and requiring evacuation of the entire deck.

Had the fire door been closed — as required — smoke spread would have been limited to the single cabin. One propped-open door. Four cabins affected instead of one. The lesson is straightforward.

## Chapter Eight

# FIRE DRILLS AND MUSTER PROCEDURES

A fire drill is not a formality. It is the only opportunity a crew has to practice the real thing before the real thing happens.

When a genuine fire alarm sounds at 0300 in heavy weather three days from the nearest port, there is no time to read a checklist, locate a fire station card, or ask what to do next.

Every action — every role, every route, every piece of equipment — must already be embedded through repetition. Drills exist to build that muscle memory before it is needed.

SOLAS is explicit on this point. Drills are not optional. They are mandatory, scheduled, and inspected.

## SOLAS Drill Requirements

SOLAS Chapter III requires fire drills to be conducted at the following minimum frequency:

- On vessels on voyages longer than one week: within 24 hours of departure if more than 25% of crew have not participated in a drill on that vessel in the previous month
- On all vessels: at least once per month
- On passenger ships: weekly fire and boat drills

Each drill must be recorded in the official log book including the date, time, description of the drill conducted, and any deficiencies identified.

PSC officers inspect drill records routinely — gaps in the log are a deficiency in themselves.

## What a Fire Drill Must Include

A SOLAS-compliant fire drill is not a muster and headcount followed by everyone returning to work. A complete drill includes:

- Sounding of the fire alarm and mustering of all crew at designated fire stations
- Simulated location of the fire — crew must respond to a specific scenario
- Deployment and pressurisation of at least one fire hose
- Operation of boundary cooling — wetting down adjacent bulkheads to prevent heat spread
- Inspection and operation of the breathing apparatus sets assigned to the fire party
- Communication check between the fire team, boundary team, and bridge
- Check of survival craft and rescue boat readiness
- Accounting for all persons on board

The Master or designated safety officer must debrief the crew after every drill — identifying what worked, what did not, and what needs improvement before the next drill.

## Fire Stations and Muster Lists

Every crew member is assigned a fire station — a specific role and location in the event of a fire emergency. Fire station assignments include:

- Fire party — crew trained and equipped to enter the fire zone and fight the fire directly
- Boundary cooling team — crew assigned to cool bulkheads and decks adjacent to the fire zone
- Emergency squad — backup team ready to assist or relieve the fire party
- Bridge team — officer and ratings maintaining navigation, communications, and overall command
- Medical team — crew trained in first aid, standing by to treat casualties
- Engine room team — engineers managing propulsion, power, and fixed system readiness

Every crew member must know their station, their route to it, and their duties — without referring to the muster list.

## Breathing Apparatus Familiarisation

The self-contained breathing apparatus — SCBA — is the most critical piece of personal protective equipment used in firefighting on ships.

Drills must include practical familiarisation with SCBA sets for all crew members assigned to the fire party:

- Physically donning the set including face mask and harness
- Checking cylinder pressure before entry
- Conducting a positive and negative pressure face seal test
- Understanding the low-pressure warning alarm and what it means for exit timing
- Practising communication with the team while wearing the mask

An SCBA set that has not been regularly practiced with is nearly useless under stress. Donning a breathing apparatus for the first time during a real fire is not a situation any crew member should ever face.

## Common Drill Deficiencies

PSC officers and company auditors frequently find the same problems recurring in fire drill records and practices:

- Drills conducted at the same time of day every month — eliminating the element of surprise
- Fire scenarios that never change — always the same location, always the same type of fire
- Hoses deployed but never pressurised
- Breathing apparatus sets checked on paper but never physically donned
- New crew members not briefed on their fire station before departure
- Drill debriefs skipped or reduced to a verbal summary with no corrective actions recorded

Effective drills are unpredictable, varied, and followed by honest debriefs. A drill where everything goes perfectly every time is a drill that is not testing anything useful.

**Example — Night Drill Reveals Critical Gap — Container Ship, Atlantic Crossing**

A container ship Master schedules an unannounced fire drill at 0130 during a North Atlantic crossing. The drill reveals three problems that daytime drills had never exposed: the second officer cannot locate his SCBA set in the dark, one AB goes to the lifeboat station instead of his fire station, and the fire hose on the primary attack position cannot be connected because the coupling is corroded and seized.

None of these problems would have appeared in a standard daytime drill. All three would have been catastrophic in a real fire. The corrective actions were completed before the vessel reached its next port. That is exactly what a drill is for.

## Chapter Nine

# FIGHTING A FIRE ON BOARD: PRACTICAL ACTIONS

When the fire alarm sounds for real, the first sixty seconds determine everything.

Not the first hour. Not the first ten minutes. The first sixty seconds — the actions taken or not taken in the immediate moments after the alarm activates — set the trajectory of the entire incident.

A crew that responds correctly in those sixty seconds contains the fire. A crew that hesitates, panics, or goes to the wrong location loses the initiative and may never recover it.

This chapter is about what actually happens during a shipboard fire — the actions, the sequence, the command structure, and the decisions that determine whether a fire is controlled or whether it controls the ship.

### The First Response — Bridge Actions

When the fire detection panel activates on the bridge, the Officer of the Watch must act immediately and in sequence:

- Sound the general alarm
- Note the zone of activation and inform the Master
- Stop ventilation to the affected area
- Post a lookout or assign a rating to watch the indicated zone from a safe position

- Begin logging — time of alarm, zone, actions taken

The bridge does not fight the fire. The bridge controls the ship, maintains communications, coordinates the response, and ensures no one is unaccounted for.

## The Incident Commander

On most merchant vessels the Master acts as overall incident commander. The Chief Officer typically leads the firefighting operation on scene. This separation of command — Master on the bridge, Chief Officer at the fire — ensures that decisions about the ship remain with one person while firefighting decisions are made by another.

The incident commander at the fire must establish communications with the bridge before entry, confirm team members are accounted for before and after each entry, never allow crew to enter a fire zone without a charged hose line and breathing apparatus, maintain a tally of SCBA cylinder pressures and withdrawal times for all personnel inside, and make the call to withdraw if conditions deteriorate.

## Boundary Cooling

While the fire party attacks the fire from the front, the boundary cooling team works to prevent it from spreading through the ship's structure. Heat conducts through steel rapidly — a bulkhead adjacent to a major engine room fire can reach ignition temperature on the far side within minutes.

Boundary cooling involves directing water continuously onto bulkheads, decks, and overheads adjacent to the fire zone, monitoring the temperature of structural surfaces by touch, and keeping access doors and hatches closed unless actively in use. On many ships it is boundary cooling — not direct attack — that prevents a contained engine room fire from becoming a vessel loss.

## Ventilation Control

Fire needs oxygen. Ventilation supplies it. One of the earliest actions in any fire response is stopping ventilation to the affected space — cutting the oxygen supply and slowing the fire's growth. On modern ships this can be done remotely from the bridge fire control panel.

Opening a hatch or door to a fire space without thinking — to see the fire, to rescue equipment, out of panic — can feed a surge of fresh oxygen into a space that was beginning to be controlled. This single action can transform a manageable fire into an uncontrollable one.

## Firefighting Team Entry Procedures

No crew member enters a fire zone alone. SOLAS requires at minimum two crew members equipped with breathing apparatus to enter together, with a third crew member standing by outside the entry point in full gear as rescue standby. Before entry the team must confirm:

- SCBA cylinders are full — minimum 90% pressure
- Face mask seal is tested and confirmed

- Communications with the bridge are established
- The entry point can be closed behind them
- A withdrawal signal has been agreed

## When to Abandon Firefighting

There are situations where continuing to fight a fire puts lives at greater risk than withdrawing and containing.

The Master must make this call clearly and without hesitation when:

- Crew members are unaccounted for inside the fire zone
- The fire has spread beyond the ability of the crew to contain it
- Structural integrity of the affected area is compromised
- Abandoning ship becomes the safer option

Withdrawing from a fire is not failure. It is a command decision based on available resources, risk to personnel, and the realistic probability of success. A ship can be replaced. Crew cannot.

## Mayday and External Assistance

The Master must not delay calling for external assistance out of optimism or pride.

A Mayday should be broadcast when the fire cannot be controlled with available crew and equipment, when there are casualties requiring medical evacuation, or when the structural integrity or stability of the vessel is threatened.

Coast Guard, nearby vessels, and rescue coordination centres can mobilise quickly — but only if they are informed quickly. Every minute of delay in broadcasting a Mayday is a minute of response time lost.

## Example — Controlled Withdrawal Saves Crew — Chemical Tanker Engine Room Fire

A chemical tanker experiences a major engine room fire following a turbocharger explosion that ruptures a fuel oil line.

The fire party makes two entry attempts but is driven back both times by heat and smoke beyond the capability of their protective equipment.

The Master, assessing that the fire has exceeded the crew's firefighting capacity, makes three decisions in rapid sequence: withdraw all personnel, activate the $CO_2$ fixed system, and broadcast a Mayday.

A coast guard vessel and two merchant ships respond. The $CO_2$ system controls the fire. All crew are evacuated safely.

The Master later stated that the decision to stop fighting was made earlier than he felt comfortable with.

The post-incident investigation confirmed it was the correct decision and that a further entry attempt would likely have resulted in crew casualties.

Knowing when to stop is as important as knowing how to fight.

## Chapter Ten

# FIRE PREVENTION: DAILY HABITS THAT SAVE LIVES

Every fire on a ship was preventable.

That is not an overstatement. Ship fires do not happen randomly. They happen because a fuel source met an ignition source in a place and at a time when someone failed to prevent it.

The leaking fuel line that was reported but not repaired. The oily rags left near a hot exhaust. The electrical cable routed too close to a heat source. The galley deep fryer left unattended.

Fire prevention is not a programme or a checklist. It is a culture — a set of daily habits practiced by every person on board, in every department, on every watch.

When prevention fails, everything in the preceding nine chapters becomes necessary. When prevention works, none of it is needed.

### The Most Common Causes of Ship Fires

Across incident databases and maritime casualty reports, the same causes appear repeatedly:

- **Fuel oil leaks onto hot surfaces** — the single most common cause of engine room fires. High-pressure fuel lines that develop small leaks spray atomised fuel onto exhaust manifolds and turbocharger casings
- **Electrical faults** — overloaded circuits, degraded insulation, loose connections, and unauthorised modifications to electrical systems

- **Galley fires** — unattended cooking, grease buildup in exhaust ducting, and incorrect equipment use
- **Smoking in unauthorised areas** — cabins, store rooms, and cargo areas
- **Hot work without permits** — welding, cutting, and grinding operations conducted without proper controls
- **Spontaneous combustion in cargo** — certain cargo types including coal and fish meal can self-ignite in holds

## The Hot Work Permit System

Any work that generates heat, sparks, or open flame on a ship outside of designated safe areas requires a hot work permit. The permit system requires:

- Risk assessment of the work area before work begins
- Confirmation that adjacent spaces are clear of flammable materials and vapours
- A designated fire watch — a person whose sole responsibility during hot work is to watch for fire with an extinguisher in hand
- Continuation of the fire watch for at least thirty minutes after hot work is completed
- Written authorisation from the Master or Chief Officer

Hot work conducted without a permit is one of the most common causes of serious shipboard fires and is a serious disciplinary and safety violation.

## Electrical Safety

Electrical fires are largely preventable through disciplined maintenance and correct equipment use:

- Never overload circuits or use extension cables as permanent wiring solutions
- Report any sign of electrical fault — burning smell, flickering lights, tripped breakers — immediately
- Ensure all electrical modifications and repairs are carried out by a qualified electrician
- Keep electrical panels and switchboards free of stored items that could restrict airflow
- Regular insulation resistance testing of critical circuits

## Good Housekeeping as Fire Prevention

The connection between cleanliness and fire safety is direct and well established. Key housekeeping practices include:

- Disposing of oily rags in metal bins with closing lids — never leaving them in open waste bins near machinery
- Regular cleaning of galley exhaust ducting to remove grease buildup
- Keeping engine room bilges clean and free of oil accumulation
- Removing unnecessary combustible materials from machinery spaces
- Ensuring store rooms are organised and free of excessive stock that could fuel a fire

A clean ship is a safer ship. This is not a cliche — it is directly supported by casualty investigation data.

## The Role of Every Person on Board

Fire prevention is not the responsibility of the safety officer alone. It is the responsibility of every person on board, in every department, on every watch. This means:

- Reporting fuel or oil leaks immediately — not at the end of the watch
- Never bypassing or disabling fire detection equipment for convenience
- Keeping fire doors closed and never propping them open
- Not smoking outside designated areas under any circumstances
- Raising the alarm immediately when something looks or smells wrong

## Building a Fire Safety Culture

Rules and checklists create compliance. Culture creates safety. The difference between a ship where fire prevention is lived every day and one where it is performed for inspections lies entirely in leadership — in whether the Master, Chief Engineer, and senior officers demonstrate through their own behaviour that fire safety is not negotiable.

On ships with strong safety cultures, a junior rating who spots a fuel leak stops work and reports it without hesitation — because they have seen their senior officers do the same thing. No ebook, training course, or regulation creates that culture. Leadership does.

## A Final Word

Fire at sea is one of the oldest and most serious risks in maritime history. The regulations, systems, and training that exist today were built on decades of hard lessons — incidents where ships were lost and lives were taken because something was not detected early enough, not contained quickly enough, or not prevented at all.

This guide has taken you from the basics of how fire behaves on a ship to the systems that detect and suppress it, the procedures that contain and fight it, and the daily habits that prevent it.

Whether you are a cadet reading this before your first voyage, an experienced officer refreshing your knowledge, or a shore-based professional overseeing fleet safety — the principles in these pages apply to every vessel, every flag, and every rank.

Fire safety is not a subject you learn once and set aside. It is knowledge you carry on every watch, in every space, on every ship.

# ADDITIONAL RESOURCES FOR SEAFARERS

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