NFPA 1405

Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires

2001 Edition

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An International Codes and Standards Organization

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Guide for

Land-Based Fire Fighters Who Respond to Marine Vessel Fires

2001 Edition

This edition of NFPA 1405, *Guide for Land-Based Fire Fighters Who Respond to Marine Vessel Fires*, was prepared by the Technical Committee on Fire Service Training and acted on by the National Fire Protection Association, Inc., at its November Meeting held November 12–15, 2000, in Orlando, FL. It was issued by the Standards Council on January 13, 2001, with an effective date of February 9, 2001, and supersedes all previous editions.

This edition of NFPA 1405 was approved as an American National Standard on February 9, 2001.

Origin and Development of NFPA 1405

This guide was developed in response to a recognized need in the area of fire fighter training. Marine vessel fires constitute one of the greatest challenges that structural fire fighters can face. The Technical Committee on Fire Service Training helped to establish a subcommittee of experts on the subject of shipboard fire fighting. The results of the subcommittee's efforts were contained in the first edition of NFPA 1405 in 1990.

The 1996 edition contained some minor updates to the original edition.

This 2001 edition contains additional updates to the original edition, including material about responder safety, vessel familiarity, vessel detection systems, incident command considerations, and a reminder that every vessel response should initially be treated as a hazardous materials incident. Some material from Appendix A has been moved into a new Appendix B, Pre-fire Survey Guide, to provide more visibility for this important sample survey.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on all fire service training techniques, operations, and procedures to develop maximum efficiency and proper utilization of available personnel. Such activities can include training guides for fire prevention, fire suppression, and other missions for which the fire service has responsibility.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Appendix A.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

Information on referenced publications can be found in Chapter 16 and Appendixes D and F.

Chapter 1 Introduction

1.1 Scope.

1.1.1 This guide identifies the elements of a comprehensive marine fire-fighting response program including, but not limited to, vessel familiarization, training considerations, pre-fire planning, and special hazards that enable land-based fire fighters to extinguish vessel fires safely and efficiently. In general, the practices recommended in this publication apply to vessels that call at United States ports or that are signatory to the Safety of Life at Sea (SOLAS) agreement.

1.1.2 This document does not consider offshore terminals or vessels on the high sea.

1.2 General Information.

1.2.1 The tactics and strategies utilized to attack a fire aboard a vessel are in many ways similar to those used routinely in attacking structure fires. However, there are many aspects of marine fire fighting that warrant special attention because of the unique environment encountered aboard a vessel. Ships often are compared to high-rise buildings. This is not an altogether inappropriate comparison. However, the ventilation of a vessel fire can be more difficult to achieve and the spread of a fire more difficult to check. The fire fighter's natural response when confronted with a structure fire is to act immediately. This is because most structure fires exhibit similar characteristics that have been encountered before and thus there is a source of knowledge and experience from which to draw. However, a major fire aboard a ship seldom occurs, and very few fire fighters have experienced such a fire. Therefore, fires aboard ship should be approached in a quick but safe and prudent manner. Fire fighters have come to realize that when they approach hazardous material incidents, it is preferable to proceed slowly rather than to react too quickly, thus increasing risks and jeopardizing success. The same is also true when fighting vessel fires.

1.2.2 Unlike structure fires, hazardous material incidents, and many other fireground operations for which there is extensive written material available for fire service personnel to study, there is relatively little information available to land-based fire fighters concerning the management of a fire aboard a vessel. The absence of this type of information often leads fire fighters to apply strategies and tactics associated with structure fires to fires aboard vessels. Although these strategies and tactics are similar, it is important to recognize that there are distinct differences in the two types of fires.

Incidents in the marine environment are usually larger in scale than those encountered on land. For example, some fire departments are prepared to deal with an incident involving an 8000-gallon tank truck fire. A bulk liquid barge can easily hold several million gallons of product. Tank vessels may hold as much as 84 million gallons and be almost a quarter mile in length. These types of incidents require planning and resources that far exceed a routine fire department response.

1.2.3 To address this major void in knowledge and understanding of vessel fire-fighting procedures, NFPA, at the request of and in cooperation with the United States Coast Guard (USCG), and with the assistance of the fire service and maritime communities, has undertaken the task of developing this guide for use by local fire-fighting organizations that could be confronted with a fire aboard a vessel.

1.2.4 Because there is extensive written material available concerning structure fires, hazardous material incidents, and other fireground operations, this guide provides only limited discussion of those aspects of vessel fire-fighting procedures that are similar. Those aspects that are different are emphasized and highlighted throughout this document.

1.3 Definitions.

1.3.1 Accommodation Spaces. Spaces designed for living purposes for occupants of a vessel.

1.3.2 Admiralty Law/Maritime Law. A court exercising jurisdiction over maritime cases.

1.3.3 After (Aft). The direction toward the stern of the vessel.

1.3.4* Anchorage. An area identified for safe anchoring.

1.3.5 Athwartship. Side to side, at right angles to the fore and aft centerline of a ship.

1.3.6 Ballast. Weight, liquid or solid, added to a ship to ensure stability.

1.3.7 Ballast Tank. A watertight compartment to hold liquid ballast.

1.3.8 Barge. A long, large vessel, usually flat-bottomed, self-propelled, towed, or pushed by another vessel, used for transporting materials.

1.3.9 Beam. The breadth (i.e., width) of a ship at its widest point.

1.3.10 Berth. (1) The mooring of a boat alongside a bulkhead, pier, or between piles. (2) A sleeping space.

1.3.11 Berthing Area. (1) A bed or bunk space on a ship. (2) A space at a wharf for docking a ship.

1.3.12 Bilge. The lowest inner part of a ship's hull.

1.3.13 Bitts. A pair of heavy metal posts fastened on a deck to which mooring lines are secured.

1.3.14 Boom. (1) A long pole extending upward at an angle from the mast of a derrick to support or guide objects lifted or suspended. (2) A floating barrier used to confine materials upon the surface of the water (e.g., oil).

1.3.15 Bow. The front end of a boat or vessel.

1.3.16 Bulkhead. (1) One of the upright, vertical partitions dividing a ship into compartments and serving to retard the spread of leakage or fire. (2) A fixed pier or wall back-filled to be continuous with the land.

1.3.16.1 Watertight Bulkhead. A bulkhead (wall) strengthened and sealed to form a barrier against flooding in the event that the area on one side fills with liquid.

1.3.16.2 Watertight Transverse Bulkhead. A bulkhead through which there are no openings and that extends from the tank top up to the main deck, built to control flooding.

1.3.17 Buoyancy. (1) The tendency or capacity to remain afloat in a liquid. (2) The upward force of a fluid upon a floating object.

1.3.18 Centerline. A line that runs from the bow to the stern of the vessel and is equidistant from the port and starboard sides of the vessel.

1.3.19 Coaming. The raised framework around deck or bulkhead openings to prevent entry of water.

1.3.20 Cofferdam. A void between the compartments or tanks of a ship for purposes of isolation.

1.3.21 Companionway. An interior stair-ladder used to travel from deck to deck, usually enclosed.

1.3.22* COTP. United States Coast Guard Captain of the Port.

1.3.23 Damage Control Locker/Emergency Gear Locker. A locker used for the storage of emergency equipment.

1.3.24 Deck. A platform (floor) extending horizontally from one side of a ship to the other.

1.3.24.1 Main Deck. The uppermost continuous deck of a ship that runs from bow to stern.

1.3.24.2 Tween Decks. Cargo decks between the main deck and the lower hold.

1.3.25 Dewatering. The process of removing water from a vessel.

1.3.26 Double Bottom. A void or tank space between the outer hull of the vessel and the floor of the vessel.

1.3.27 Draft. The depth of a vessel's keel below the waterline.

1.3.28 Drafting. The act of acquiring water for fire pumps from a static water supply by creating a negative pressure on the vacuum side of the fire pump.

1.3.29 Dunnage. Loose packing material (usually wood) protecting a ship's cargo from damage or movement during transport.

1.3.30 Escape Trunk. A vertical trunk fitted with a ladder to allow personnel to escape if trapped.

1.3.31 Fantail. The stern overhang of a ship.

1.3.32* Fire Control Plan. A set of general arrangement plans that illustrate, for each deck, the fire control stations, fire-resisting bulkheads, and fire-retarding bulkheads, together with particulars of the fire-detecting, manual alarm, and fire-extinguishing systems, fire doors, means of access to different compartments, and ventilating systems, including locations of dampers and fan controls.

1.3.33 Fire Station. A location for the fire-fighting water supply outlet, hose, and equipment on board ship.

1.3.34* Fire Warp. Wire rope or other fireproof materials of sufficient strength to tow the vessel in the event of fire.

1.3.35 Force Majeure. See Section 15.4.

1.3.36 Forecastle (fo'c'sle). (1) The section of the upper deck of a ship located at the bow, forward of the foremast. (2) A superstructure at the bow of a ship where maintenance shops, rope lockers, and paint lockers are located.

1.3.37 Forward (Fore). The direction toward the bow of the vessel.

1.3.38 Frame. The structural members of a vessel that attach perpendicularly to the keel to form the ribs of the vessel.

1.3.39 Freeboard. The vertical distance between the waterline and the main deck.

1.3.40 Gangway. The opening through the bulwarks (sides) of a ship or a ship's rail to which an accommodation ladder used for normal boarding of the ship is attached.

1.3.41 Gunwale. The upper edge of a side of a vessel or boat designed to prevent items from being washed overboard.

1.3.42 Heeling. (1) Tipping to one side. (2) Causing a ship to list.

1.3.43 Hogging. Straining of the ship that tends to make the bow and stern lower than the middle portion.

1.3.44 House. A superstructure above the main deck.

1.3.45* International Shore Connection. A universal connection to the vessel's fire main to which a shoreside fire-fighting water supply can be connected.

1.3.46 Keel. The principal structural member of a ship, running fore and aft on the centerline, extending from bow to stern, forming the backbone of the vessel to which the frames are attached.

1.3.47 Ladder. All staircases, often nearly vertical, on board vessels.

1.3.47.1 Jacob's Ladder. A rope or chain ladder with rigid rungs.

1.3.48 List. An inclination to one side; a tilt.

1.3.49 Master. The captain of a merchant ship.

1.3.50 Mate. A deck officer on a merchant ship ranking below the master.

1.3.50.1 Chief Mate. The deck officer immediately responsible to the vessel's master.

1.3.51* Mooring. (1) Equipment, such as anchors, chains, or lines, for holding fast a vessel. (2) The act of securing a vessel. (3) A location at which a vessel can be moored. (4) Any location where a boat is wet-stored or berthed.

1.3.52 Overhead. The vessel equivalent of a ceiling.

1.3.53 Passageway. A corridor or hallway.

1.3.54 Platform. (1) Any flat-topped vessel, such as a barge, capable of providing a working area for personnel or vehicles. (2) A partial deck in the machinery space.

1.3.55 Port Side. The left-hand side of a ship when facing forward.

1.3.56 Riser. A pipe leading from the fire main to the fire station (hydrants) on upper deck levels.

1.3.57 Roll-on/roll-off (ro/ro). A form of cargo handling utilizing a vessel designed to load or unload cargo that rolls, such as automobiles or tractor trailer units.

1.3.58 Sagging. Straining of the ship that tends to make the middle portion lower than the bow and stern.

1.3.59 Sail Area. The area of the ship that is above the waterline and that is subject to the effects of wind, particularly a crosswind on the broad side of a ship.

1.3.60 Scupper. An opening in the side of a vessel through which rain, sea, or fire-fighting water is discharged.

1.3.61 Shaft Alley. A narrow, watertight compartment through which the propeller shaft passes from the aft engine room bulkhead to the propeller.

1.3.62 Shaftway. A tunnel or alleyway through which the drive shaft or rudder shaft passes.

1.3.63 Should. Indicates a recommendation or that which is advised but not required.

1.3.64 SOLAS. The International Convention for the Safety of Life at Sea, 1974.

1.3.65 Starboard Side. The right-hand side of a ship as one faces forward.

1.3.66 Stern. The after end of boat or vessel.

1.3.67 Stevedore. A person employed for the loading and unloading of ships, sometimes called a longshoreman.

1.3.68 Superstructure. An enclosed structure above the main deck that extends from one side of the vessel to the other.

1.3.69 Tank Top. The lowest deck, top plate of the bottom tanks.

1.3.70 Terminal. Either end of a carrier line having facilities for the handling of freight and passengers.

1.3.70.1 Break Bulk Terminal. A terminal where commodities packaged in bags, drums, cartons, and crates are commonly, but not always, palletized and loaded and unloaded.

1.3.70.2 Bulk Terminal. A terminal where unpackaged commodities carried in the holds and tanks of cargo vessels and tankers and generally transferred by such means as conveyors, clamshells, and pipelines are handled.

1.3.70.3 Car Terminal. A terminal where automobiles are the commodity handled.

1.3.70.4 Container Terminal. A terminal that is designed to handle containers that are carried by truck or rail car where transported over land.

1.3.70.5 Dry Bulk Terminal. A terminal equipped to handle dry goods that are stored in tanks and holds on the vessel.

1.3.71 Tides. The periodic variation in the surface depth of the oceans, and of bays, gulfs, inlets, and tidal regions of rivers, caused by the gravitational pull of the sun and moon.

1.3.72 Towboat. A powerful, small vessel designed for pushing larger vessels.

1.3.73 Tug. A powerful, small vessel designed for towing larger vessels.

1.3.74 Ullage Hole. An opening in a tank hatch that allows measuring of liquid cargo.

1.3.75 USCG. United States Coast Guard.

1.3.76 Vertical Zone. The area of a vessel between adjacent bulkheads.

1.3.77 Watertight Door. A door that is designed to keep water out.

1.3.78 Winch. A stationary, motor-driven hoisting machine having a drum around which a rope or chain winds as the load is lifted.

Chapter 2 Marine Environment

2.1 Introduction. The marine environment presents many unique challenges. It is very important that these challenges are identified and preplanned in order to have a successful outcome. This chapter describes the elements of the physical marine environment that can be encountered by those involved in managing a fire aboard a vessel. An understanding of these elements is necessary to plan for the changing conditions that occur during a vessel fire. Local sources of expertise that are available to provide specific information on the marine environment should be identified during the planning stages.

2.2 Tides and Currents. Tides and currents are critical to the fire officer, since they produce vertical and horizontal movement of the vessel. Equipment, such as hoses and ladders, that is attached to the vessel, as well as "drafting" operations from docks and piers, can be adversely affected.

Tides are the daily changes in the depth of the water. Depending upon location, this change can vary from unnoticeable to more than 30 ft (9.2 m). Currents can range from as little as $^1/_2$ knot to more than 10 knots.

Changes in the tide should be considered when mooring or anchoring a vessel and during fire suppression activity. The following concerns should be addressed:

(1) The vessel can become grounded, which, in turn, can cause listing or capsizing.
(2) Tides may put additional strain on the mooring system of a vessel and can even compromise a weakened system.
(3) Tides should be monitored to ensure that drafting operations are not affected.
(4) Ground ladders placed against a vessel must be monitored at all times.
(5) Operators of aerial apparatus must stay with equipment at all times to prevent damage or injury. Aerial apparatus should never be placed directly against the side of a vessel.
(6) Tide levels will also affect clearance under bridges and may prevent fire and rescue vessels from accessing the scene.

Currents can result from tide changes and river flow. Tidal currents change direction at predictable intervals. River flow increases or decreases the tidal current. The river flow rate usually increases during spring runoff and decreases during summer and fall droughts.

Currents affect the movements of vessels and boats. They put additional strain on the mooring system of a vessel and can even compromise a weakened system. When currents hit obstructions in the water, such as piers, they often change direction and form whirlpools and eddies. Fireboats and rescue boats maneuvering around piers can find it very difficult to maintain their position in these swirling waters. People who fall overboard into strong currents can be pulled under piers, barges, or vessels by these currents and can become trapped underneath them.

The Coast Guard, the vessel crew, and others who work in the port can estimate tides and tidal currents from tide tables and current tables produced by the National Oceanic and Atmospheric Administration (NOAA). For local conditions around piers and in channels, docking pilots and channel pilots should be consulted.

2.3 Weather. Observing and reporting the actual weather conditions at the site of an incident is of critical importance to planning and executing an effective response. Observations of the on-scene weather conditions should be reported to the command post at regular intervals. Changes in on-scene weather conditions also are to be reported as soon as they are recognized.

A variety of weather forecasting information sources might be available to the incident commander for planning and modifying fire-fighting strategies. Local National Weather Service (NWS) offices might be able to provide weather forecasts that are specific to the location and nature of the incident. Continuous weather forecasts are broadcast by the NOAA on VHF-FM channels. The USCG has maritime weather observations and forecasts available for use by the incident commander. The command post should monitor appropriate VHF-FM channels (usually marine CH-16 and CH-22A) for Coast Guard urgent marine information broadcasts that warn of severe weather. Local airport Federal Aviation Administration (FAA) offices might make aviation weather observations and forecasts available.

Weather conditions over water are often different from the weather experienced over land. Rapid changes of the weather occur frequently in coastal areas and can take incident responders by surprise. Weather observations and forecasts for offshore conditions can become less accurate as the distance from shore increases.

The wind speed and temperature over water can be expected to be different from conditions observed over land. Temperatures over water can be a few degrees warmer during the winter but cooler during the summer. A breeze can be blowing along the coast even when it is calm inland because of this temperature difference. Winds can be stronger along the coast or in harbors where there are few obstructions. Weather can stop or hinder fire-fighting operations on boats under way. Winter weather can also have significant impacts on fire-fighting operations. Vessels with aluminum or fiberglass hulls may not be able to navigate in waters that contain ice, which may hinder or prevent fire-fighting and rescue operations. Ice can also prevent drafting operations at the waterfront; thus additional time and hose lays may be required to provide an adequate water supply.

2.4 Vessel Traffic. The amount and type of vessel traffic vary from port to port, within a port, and along waterways. Vessels, such as fishing vessels, sailboats, pleasure boats, naval vessels, and deep-draft vessels, all present varying traffic problems. Vessel traffic may also create wakes and other hazards that could result in damage to response vessels or injury to responders. The Coast Guard Captain of the Port has the authority and resources to control vessel traffic in the harbor. *(See Chapter 12 for further information.)*

2.5 Channels and Navigation. Nautical charts are maps of a harbor, river, or bay that indicate the channels used by vessels to enter and leave a port. They also provide the projected depth of the channels and the buoys and beacons that mark the channel. These channels are similar to highways and have their own set of rules of the road that apply to all vessels. Operators of response vessels should be fully trained in safe navigation techniques.

Many larger vessels are under the guidance of a local professional pilot(s) who has extensive knowledge of local conditions.

2.6 Designated Fire-Fighting Anchorage and Piers. The USCG determines the locations of fire-fighting anchorages in the port and along waterways. The USCG also enforces the anchorage regulations. Moving a burning vessel to an anchorage often reduces exposure problems but could increase access and pollution problems. Even if a sufficient number of vessels or platforms can be obtained to gain access to the vessel, fighting a fire from a platform while exposed to the weather and currents is much more difficult than fighting a fire from a pier. An anchorage can be an excellent temporary location for the vessel while fire-fighting resources are being coordinated and a more advantageous location is sought.

Designated piers and anchorages should be, and usually are, provided in the U.S. Coast Guard Firefighting Contingency Plan for the area. *(See Chapter 12.)*

2.7 Bottom Conditions. Bottom conditions should be evaluated when a vessel is anchored or moored. An anchor might fail to hold on a rocky bottom, while it could hold too well on a muddy bottom, making the anchor difficult to pull up. The nautical chart of the area identifies the bottom conditions (e.g., mud, sand, rock, wrecks). When a vessel is moored to a pier and in danger of settling to the bottom due to an excess of fire-fighting water, the slope of the bottom determines how the vessel comes to rest. At some piers, the bottom is sloped steeply toward a deeper channel. A vessel settling on this bottom can slide out toward the channel or capsize. Preplans of berthing facilities should contain information about the bottom conditions.

2.8 Marine Terminal Types. Marine terminals vary in characteristics such as type, size, age, construction, and cargo-handling and fire-fighting equipment. The different types of marine terminals are as follows.

(a) *Liquid Bulk Terminal.* Transfers liquids such as oils, chemicals, and liquefied gases from tank vessels, through a fixed pipeline, and to large onshore storage tanks.

(b) *Dry Bulk Terminal.* Transfers items such as cement, grain, coal, salt, and fertilizer in bulk quantities, usually using bucket cranes and conveyor belts. Storage is in piles on the ground or in large warehouses.

(c) *Container Terminal.* Transfers containers [8.5–9.5 ft high × 8 ft wide × 20–40 ft long (2.6–2.9 m high × 2.4 m wide × 6.1–12.2 m long)] from vessels to ground storage, chassis, or rail cars using specialized movable cranes.

(d) *Break Bulk Terminal.* Transfers nonbulk cargo, such as raw rubber, lumber, bags of cocoa and coffee beans, steel coils, and heavy machinery, to large transit sheds and warehouses using the ship's equipment or cranes. This method is very labor intensive.

(e) *Motor Vehicle Terminal.* Transfers vehicles that are driven from large car carriers to large storage parking lots on the terminal.

(f) *Roll-on/roll-off Terminal.* Transfers freight containers on transportation means such as chassis, trailers, and motor vehicles that are driven on or off the vessel using special piers or vessel ramps, or both.

(g) *Rail Terminal.* Transfers railcars that are driven on or off the vessel on tracks located on the vessel and terminal and connecting the vessel and terminal.

(h) *Ferry/Passenger Terminal.* Transfers passengers, their vehicles, their baggage, and other belongings. The operations at a large cruise ship terminal are similar to those at an airport. Access to and from ferry/passenger vessels is normally through one point at the terminal. This creates difficulties if responders are attempting to gain access to a vessel when passengers are exiting. A secondary access point is sometimes available where crew and supplies access the vessel. Pre-fire plans should identify all access points for emergency response personnel.

2.9* Piers and Wharves. Piers and wharves are constructed from materials that vary from concrete pilings and surfacing to wooden pilings with wooden or concrete decking. Ideally, vessel fires should be fought from concrete piers or wharves. The construction of buildings on piers and wharves also varies considerably.

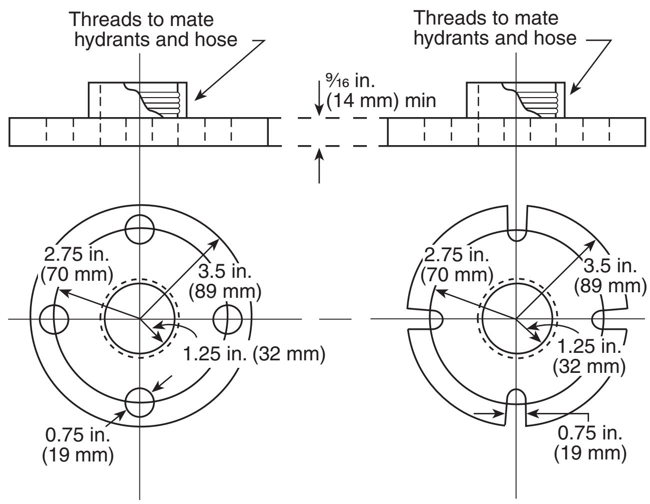
2.10* Shipyards and Dry Docks. Because of the nature of the work [e.g., welding, burning (cutting), grinding], many vessel fires have occurred in shipyards and dry docks. These areas are typically crowded with people and machinery. Ship systems, including fire-fighting systems, can be inoperable due to repair. Access to the pier or dry dock is difficult. A vessel in a dry dock might stand 100 ft (30.5 m) out of the water with only one gangway leading into the ship from the top of the dry dock. Openings might be cut in the vessel, which contribute to the spread of smoke and fire.

2.11 Moorings. Vessels are moored to piers and wharves using wire or rope lines. Efforts should be made to protect mooring lines so that they do not burn through or break, setting the vessel adrift. On deck, mooring lines usually are handled on large power winches. Without power to these winches, mooring a vessel becomes very difficult. During vessel incidents, operations should be kept clear of all mooring lines and these lines should be frequently monitored for excessive strain. If the vessel stability changes, mooring lines can be strained to the point of parting or separation, causing a hazard for emergency personnel. Mooring lines can break with such force that they can kill or seriously injure personnel or damage equipment. Some winches are automatic and self-tensioning and can move without warning, creating hazards to personnel.

2.12 Cranes. Vessels often have their own cargo-handling gear (cranes and booms), which could be useful during a fire. At terminals, cargo-handling cranes come in various shapes, sizes, and capacities. They range from large container and derrick cranes to small mobile cranes. Marine construction companies usually operate cranes on barges that can be towed throughout the port. They can be useful if ship or terminal cranes have been damaged or cannot be used.

2.13* Shoreside Fixed Fire-Fighting Equipment. Some piers and wharves are equipped with fixed fire-main and potable water systems. The connections to these systems need to be examined to ensure that fire-fighting equipment can be connected to them. There is a way to connect a shore fire-main system to a vessel fire-main system by connecting two "international shore connections" (*see Figure 2.13*). The ship's international shore connection connects to the ship's fire main and provides a standard international flange, while the shore international shore connection connects to the shore fire main and provides another standard international flange. These flanges can be bolted together to connect the two systems. The ship's international shore connection is required on all commercial vessels; however, there is no requirement to have a shore international shore connection. Therefore, each responding fire department should have its own international shore connection to adapt to the fire department thread. The international shore connection is tested only to 150 psi (1034 kPa). Care should be taken to avoid overpressurizing this device or the ship's fire-main system. Therefore, it is strongly recommended that the ship's flange be connected directly to the vessel's fire main, if possible, and not to the vessel's fire hose. This procedure can provide for cooling water for boundary protection. A means of limiting the pressure into the ship's system must be established to prevent actuation of the ship's pressure-relief valves.

FIGURE 2.13 International shore connection.



Material: Any suitable for 150 psi (1034 kPa) service
Flange surface: Flat face
Gasket material: Any suitable for 150 psi (1034 kPa) service
Bolts: Four 5/8-in. (16-mm) minimum diameter, 2-in. (51-mm) long, threaded to within 1 in. (25.4 mm) of bolt head
Nuts: Four, to fit bolts
Washers: Four, to fit bolts

Material: Brass or bronze suitable for 150 psi (1034 kPa) service

2.14 Shore Connections. Vessels sometimes take on potable water and fuel and sometimes are connected to shoreside electricity, sanitary water and sewer, bilge water, telephone, and other services while at a pier. These connections might need to be disconnected during fire-fighting efforts.

Chapter 3 Vessel Familiarization

3.1 Ship Construction. Modern ships are constructed mainly of steel plates that are welded together, including the decks and vertical framing. The interior bulkheads can be made of steel or other materials, provided that they meet the fire-resistive requirements of the bulkhead.

Aluminum and other alloys sometimes are used in noncritical areas. Structural aluminum normally is found only above the main deck. The heat of a shipboard fire causes aluminum structures to sag or melt much more quickly than steel structures.

Composite materials, metal, or cored laminated panels are often used for bulkheads in accommodation and berthing areas.

Bulkheads can be rated in a manner similar to partitions in buildings, as detailed in Table 3.1.

Table 3.1 Bulkhead Rating

Classification	Rating
A-60	1 hr
B-30	30 min
C	No rating

Note: See 46 *CFR* 72.05–72.10 for additional information.

3.1.1 Ship Structure. Response personnel must familiarize themselves with terminology commonly used in the marine environment, such as *bow* for front and *stern* for the back of a vessel as well as *port* and *starboard* for left and right, respectively. These terms will be essential in size-up as well as in directing operations.

Ships are framed in a manner similar to buildings. The outer shell or plating and the decks provide the main frame of the ship. The main girder of the vessel is called the keel.

Vessel diagrams provide information on the vessel's layout of compartments. They are similar to building diagrams, and they may assist in determining the location of fire, potential extension, and exposures. Response personnel should consult with marine experts when reading and interpreting vessel diagrams. The vessel diagrams will assist in developing fire-fighting strategy and are critical to the incident commander and planning section chief.

Frames, similar to human ribs, provide the internal structure to support the decks and outer shell. Frames are numbered sequentially but vary as to point of reference. Numbering begins from the bow, stern, or amidships. The compartments also are numbered. The starboard side compartments are odd-numbered, and the port side compartments are even-numbered.

Decks on military ships usually are numbered. Decks on merchant vessels are named or numbered.

Military ship decks above the main deck are numbered as "01," "02," "03," and so on. The higher the number, the higher the deck in the superstructure. Decks below the main deck are numbered as "lst deck," "2nd deck," "3rd deck," and so on. The larger the number, the lower the deck within the hull.

Merchant vessel decks are named or numbered, or both. Names vary from vessel to vessel and even within the same vessel. It is important for fire fighters to refer to the vessel's general arrangement plan to determine the correct deck name or number for a specific vessel. *[See Figures 3.1.1(a) and 3.1.1(b).]*

Ships are divided into zones by fire-resistive bulkheads and decks. The location of bulkheads and decks can be determined by referring to the ship's fire control plan.

The doors separating the vertical zones are to have the same rating as the bulkhead.

Below the main deck, the doors can be remote controlled or manually operated watertight doors, or they can be standard fire doors.

FIGURE 3.1.1(a) Pre-1949 convention compartment identification system.

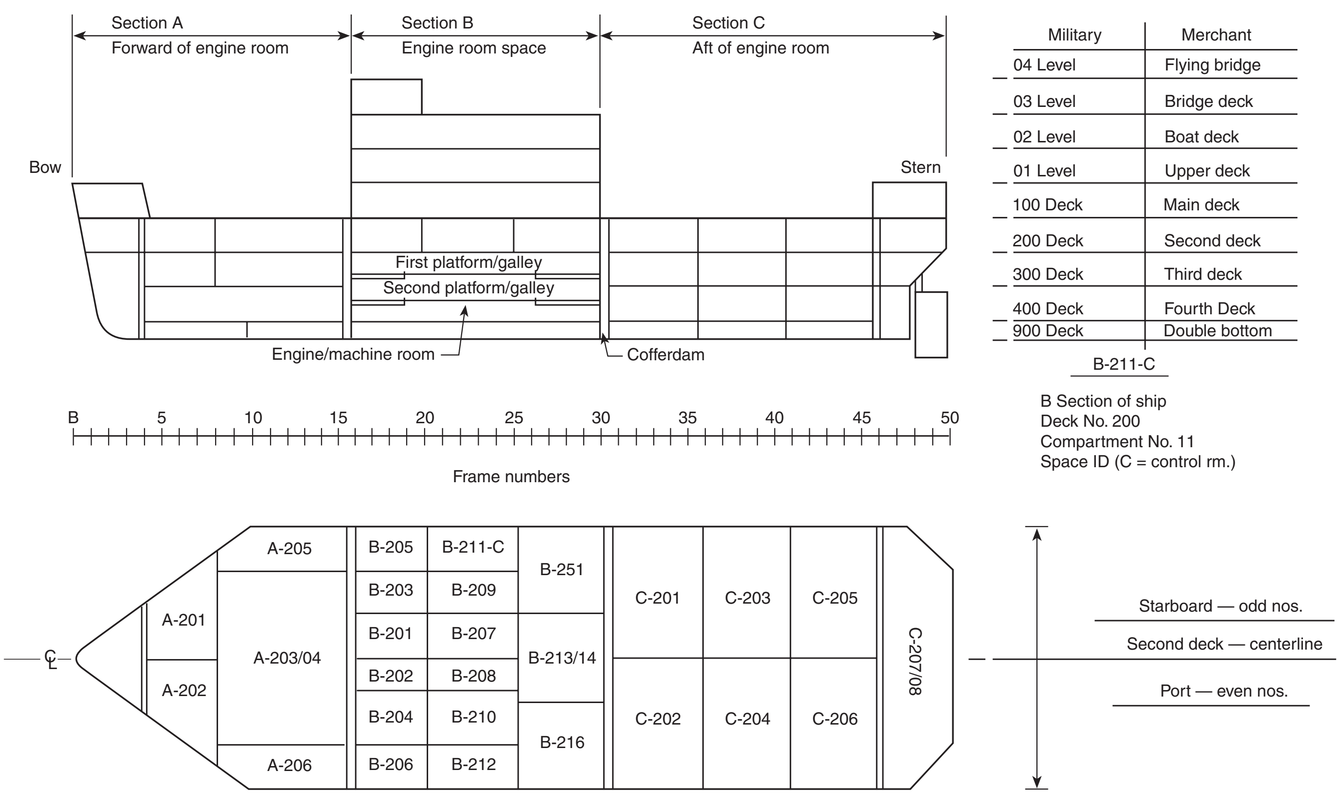
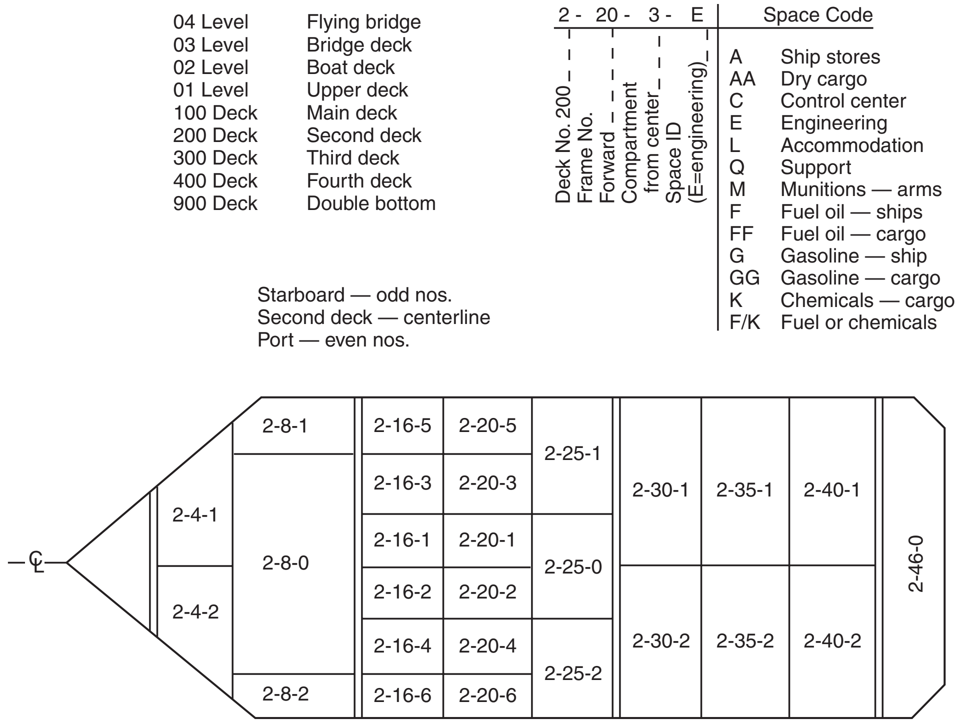


FIGURE 3.1.1(b) Post-1949 convention compartment identification system.



3.1.2 Construction. During construction, U.S. flag vessels are inspected strictly by the Coast Guard. Penetrations are sealed or protected by dampers at vertical zones.

Between the vertical zones, penetrations in bulkheads, framing, and decking may be permitted. These penetrations can cause hidden spaces to be created.

Other concealed spaces can be created due to cofferdams, shaftways, double bottoms and intakes, or discharges.

As ships age, the integrity of the vertical zones tends to diminish.

3.2 Interior Arrangements.

3.2.1 The sizes of a ship's interior spaces, ladders, companionways, and passageways are much smaller than those found in a building. It is difficult for two people to walk abreast in some passageways.

The cabins or berths usually are smaller than those found in a hotel.

Stairs are called "companionways" or "ladders." They often are steep and narrow, as well as open at the back.

3.2.2 The machinery spaces on a ship can be very large, since they commonly contain the equipment used to produce the ship's electrical and propulsive power.

Each self-propelled vessel is required to have at least two electric-generating sets. Additionally, an emergency source of power (battery or generator, or both) is to be provided.

On most U.S. flag vessels, lighting for engine rooms, boiler rooms, and auxiliary machinery spaces is supplied by two or more electrical feeders.

Because of the oils and fuels used in the machinery spaces, everything in the space should be considered to have a coating of oil upon it and, therefore, it could be slippery, especially when wet.

Much of the decking in the machinery spaces is open-webbed grating to reduce the chance of slipping. If the fire is underneath the open-webbed or expanded metal decking (grating), the flames and heat pass through and can cause injury and early structural failure.

Because of the critical nature of these spaces, they usually are protected by manually activated extinguishing systems.

All the separate compartments in the main machinery spaces require at least two exits. One of these exits is usually an escape scuttle to the deck above.

3.2.3 Cargo storage areas (holds) are large spaces in which cargo is carried. These spaces usually have hatch covers at the main deck level through which cargo is handled. There also might be covers on the decks below. If the ship is in port, these covers could be open, posing considerable risk to people on deck, particularly in a smoke-filled environment. Generally, these spaces are required to be equipped with manually operated suppression systems. Holds can have mezzanines called *tween decks* to increase storage capacity.

Tanks are holds designed to contain liquids. The tanks are emptied by the use of pumps that are aboard ship.

3.2.4 Ships are equipped with fire pumps that supply fire mains, which are similar to standpipes in buildings. At least one of these pumps is required to have an alternate or emergency source of power.

Self-propelled vessels and some barges are equipped with fire pumps that supply fire mains that are similar to standpipes in buildings. Where two or more fire pumps are required, the pumps should be arranged with separate sea connections and sources of power so that a fire in any one space cannot put all of the fire pumps out of operation.

3.3 Types of Ships. There are many types of ships that utilize the ports in the United States, but they can be classified into several main types. The vessels that are flagged/registered as American vessels comply with a slightly different set of rules than do vessels that are flagged by foreign countries. Those countries other than the U.S. participating in the Safety of Life at Sea (SOLAS) convention should comply with the SOLAS standards. Some vessel categories to which SOLAS does not apply include cargo vessels under 500 gross tons (454 m tons) (most offshore supply vessels) and vessels not propelled by mechanical means (barges and sail training ships). The major types of vessels are as follows.

(a) *Dry Bulk Carriers.* Dry bulk carriers typically carry goods such as grain, coal, iron ore, and scrap steel in large cargo holds [*see Figure 3.3(a)*]. The hazards associated with fires on these types of vessels can be compared to the hazards of grain silos, such as spontaneous combustion, dust explosions, and expansion of product due to the addition of water, with the added problem of instability. Additional care is to be taken because of the large deck openings into the holds.

(b) *Break Bulk Carriers.* Break bulk carriers are ships that carry dry cargo in smaller parcels such as crates, bags, or barrels [*see Figure 3.3(b)*]. Break bulk carriers also can contain dunnage (usually wood) used to support and separate cargo. Break bulk carriers can carry hazardous materials in their holds.

(c) *Ro/ro (Roll-on/roll-off) Ships.* Ro/ro ships are ships that carry automobiles and other vehicles. They are designed specially to carry as many vehicles as possible. These vessels can have low overheads, many decks, and sometimes straight, flat sides. They may carry a variety of trucks, tractor trailers, trailers, and vehicles. They may carry any products that can be carried by road vehicles, including hazardous materials. Ro/ro ships often carry containers on deck in addition to vehicles.

(d) *Container Ships.* Container ships are specialized carriers that carry break bulk goods in steel or aluminum containers [*see Figure 3.3(d)*]. Large container ships carry as many as 4000 20 ft (6.1 m) containers in holds and above deck.

Container ship capacity is measured in TEUs (Twenty-foot Equivalency Units), the number of 20-ft containers a ship can carry. Containers can hold hazardous material or general cargo and may be refrigerated.

(e) *Liquid Bulk Carriers.* Liquid bulk carriers are called *tankers* and are capable of carrying tremendous quantities of liquids in specially designed holds called *tanks* [*see Figure 3.3(e)*]. Tankers are sized according to volume, the smallest being called a *handy-size tanker* and the largest being called an *ultra-large crude carrier* (ULCC). The fire officer should become familiar with the sizes and types of tankers that call at the port. Some tankers carry different liquids in different tanks. Some carry 40 or more different liquids and are known as *drugstores.* A tanker also has the ability to pump off its own cargo during the off-loading process. Because of the pumps, there often is a great deal of piping on the main deck of the tanker. Care should be taken to preserve the integrity of the piping.

(f) *Passenger Vessels.* Passenger vessels can carry several thousand people. Although the passenger spaces are similar to those in a hotel, there are several differences that should be noted. The corridors (passageways) are considerably more narrow than those in a hotel. The rooms also are smaller. The areas to which people can be evacuated on a ship are limited.

(g) *Ferries.* Ferries usually are a combination of automobile carriers and passenger vessels that traverse smaller bodies of water, such as harbors, lakes, and rivers; however, some are quite large ocean-going vessels. Ferries usually resemble floating parking garages with large, undivided spaces. Passenger spaces are located within the superstructure. Larger ferries may have accommodation spaces similar to passenger vessels. Some ferries are capable of speeds in excess of 50 knots.

(h) *Barges.* Barges can carry any material that is carried by a larger ship. Barges often are used where deep-draft vessels cannot travel. Many barges can be tied together to form a "tow," which resembles a raft floating on the water.

(i) *Multipurpose Ships.* Multipurpose ships are designed to carry a variety of cargoes at the same time. Special systems are available to transport break bulk, refrigerated (frozen), and liquid cargoes [*See Figure 3.3(i)*].

(j) *Lighter-on-Board Ships.* Lighter-on-board ships carry smaller, barge-like craft called *lighters,* which ferry cargo from a ship anchored in deep water to shallow water ports. The lighters usually are loaded aboard the ship through openings in the stern or are lifted aboard by large ship-mounted cranes. Lighters may carry break bulk and occasionally solid bulk cargo, including hazardous materials.

FIGURE 3.3(a) Dry bulk carrier.

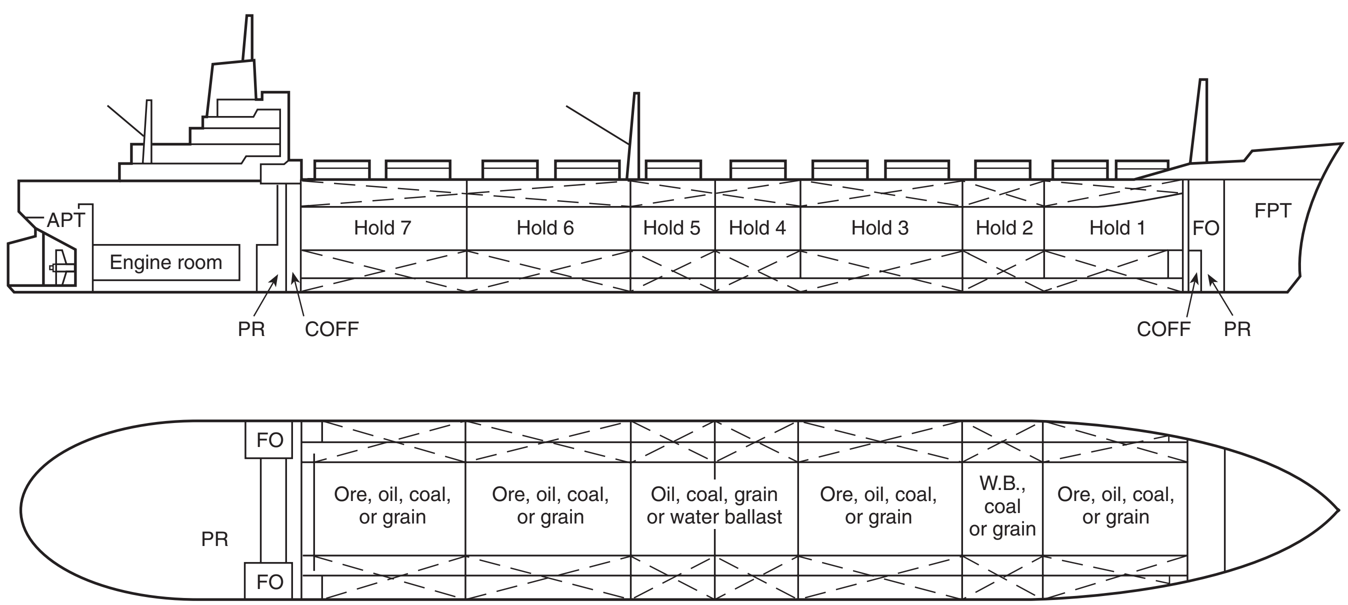


FIGURE 3.3(b) Break bulk carrier.

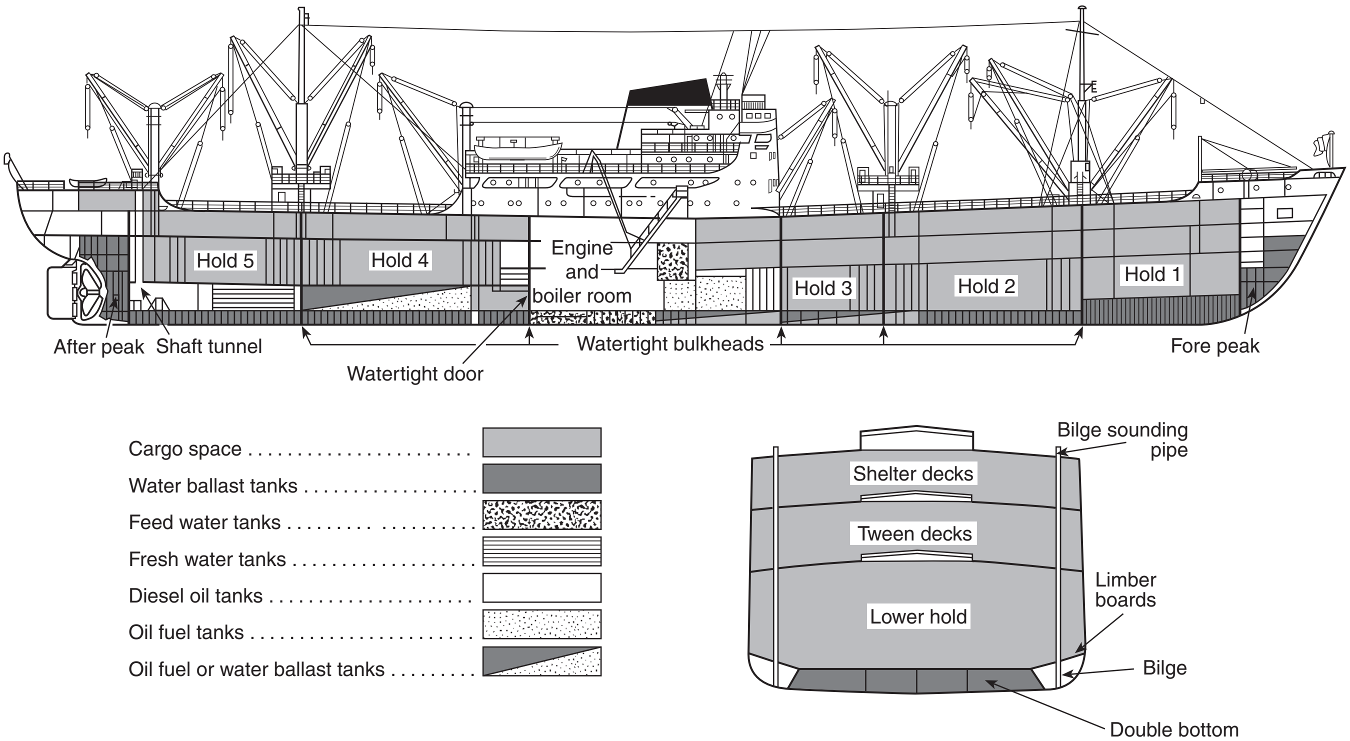


FIGURE 3.3(d) Container carrier.

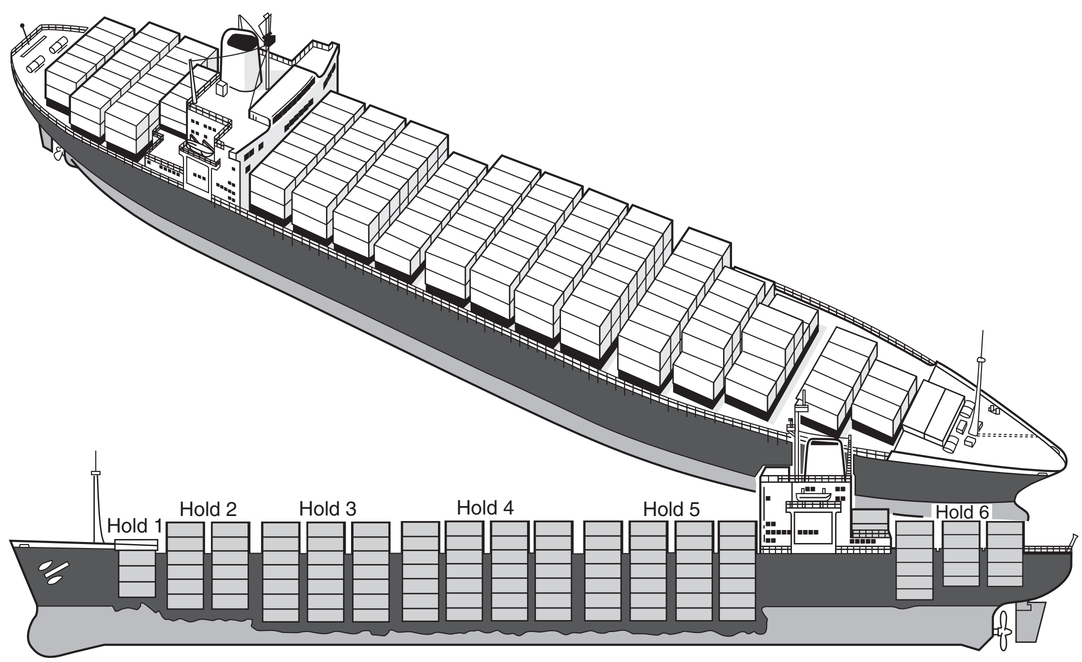


FIGURE 3.3(e) Liquid bulk carrier.

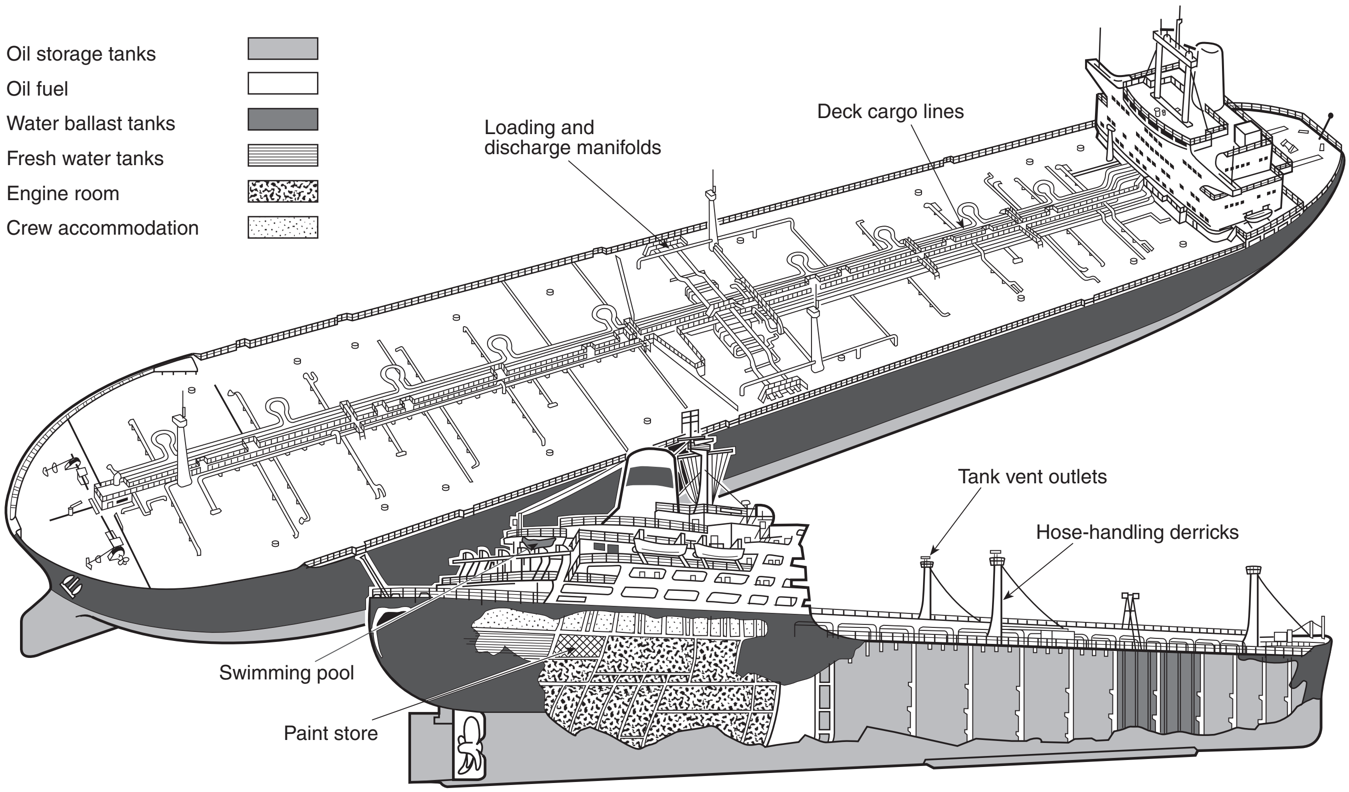
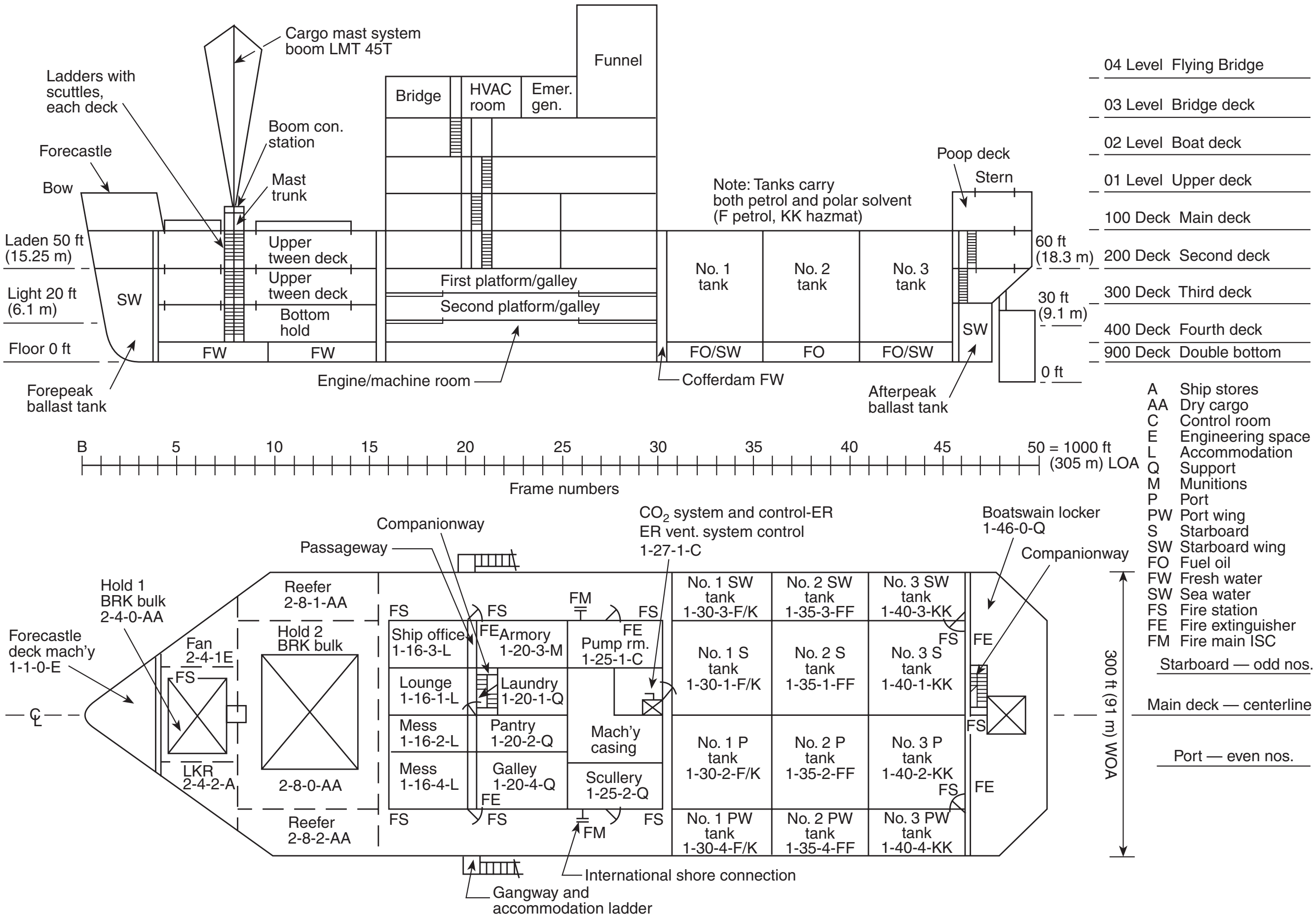


FIGURE 3.3(i) Multipurpose ship.



3.4 Ship Personnel.

3.4.1 Captain. The incident commander (IC) should utilize a ship's personnel in developing plans to respond to a marine incident. The IC should not attempt to remove such personnel from the ship upon arrival. Removing them may endanger the vessel or even create an international incident as well as exceed the authority of the fire service if the vessel flies a foreign flag. Ship personnel will be required to maintain important systems such as power and fire-fighting systems. Key crew members should be identified, and their responsibilities can be integrated into preplans. Commercial vessels normally will have watch bills that identify the responsibilities of each of the crew members during emergencies. This information can be valuable to responders when developing incident action plans.

The captain, or master, of the ship is responsible for all that happens to and upon the ship. The captain has ultimate control over the safety of the vessel. However, the safety of the port is the responsibility of the United States Coast Guard Captain of the Port.

Liaison with the ship's captain is to be established as a priority item at the outset of any incident. Courtesy and cooperation with the captain greatly enhance any operations aboard the ship. The captain will provide information on the sequence of events and the actions taken prior to the fire department's arrival. The captain also should know which systems aboard ship are available and can be used.

3.4.2 Deck Department. The deck department consists of one or more mates and other sailors. In port, the mates often are responsible for the cargo functions of the ship, including on-loading and off-loading.

The chain of command flows from the captain to the chief mate (*see Figure 3.4.2*). The chief mate is responsible for stowage of the cargo and the maintenance of the ship's stability. The chief mate can have several assistant mates who assist in the performance of assigned duties.

3.4.3* Engineering Department. The engineering department on a ship is responsible for the ship's propulsion and steering, as well as all of the ship's mechanical and electrical systems.

The engineering department is led by a chief engineer, who can have several assistants who assist in maintaining the ship's systems.

3.4.4 Steward Department. A large steward department is found on ships that carry passengers. This department is similar in function to the staff at a hotel. It is responsible for passenger comfort.

Typically, the department is led by a chief steward, who is responsible for a large staff. This department is the source of most knowledge regarding passenger accommodations.

3.4.5 Crews of International Origin. A ship's crew can be made up of people of various nationalities. As a result, there can be serious communication problems because of language barriers. The level of fire-fighting expertise and willingness to get involved in incident mitigation can vary from vessel to vessel.

3.5 Shipboard Fixed Systems.

3.5.1 Introduction. Ships, unlike barges, have built-in fixed fire systems to extinguish shipboard fires. Experience has encouraged ship designers to improve these systems to a high degree of efficiency. Crews generally are trained to use these systems. However, the number of trained crew members aboard a ship during a fire emergency and the initial damage done by a fire to the equipment or access to the fire system can render the condition of the system suspect. The system might or might not be operating properly. It might or might not have been used properly by the ship's crew and could be partially or fully expended.

3.5.2 Common Problems and Concerns.

3.5.2.1 Maintenance. While a marine environment demands the best of maintenance programs, continuous changes in operating personnel can result in ship systems that are not as well maintained as those that are based on land.

3.5.2.2 Hardware Compatibility. With the exception of U.S. ships, components of shipboard systems are supplied by companies throughout the world in many configurations. Fittings and thread types and sizes are examples of equipment that could prevent a land-based fire fighter from connecting to a shipboard system.

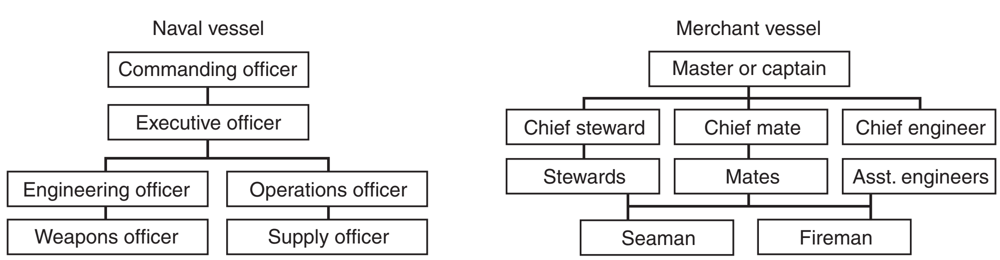
3.5.3 Fire-main Systems. The primary intent in the design and construction of a fire-main system is to provide the crew with protection for its ship. Therefore, such systems are designed for use by nontrained fire fighters. The design intent is similar to that of Class II standpipe systems as defined in NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems.*

3.5.3.1 Fire Mains. Fire mains are configured either as loops or as "dead-end" (riser) mains. The loop obviously is preferred, because a break on the fire main between the pump and the fire can be valved off and water can be pumped to the fire from an alternate route.

3.5.3.2 Branch Lines. Branch lines run from the fire main to the fire station. The pipe diameter is usually $1^1/_2$ in. to $2^1/_2$ in. (38 mm to 64 mm) or the equivalent.

3.5.3.3 Fire Stations. Fire stations usually consist of a hydrant with the required hose and nozzles. Stations should be located so that all portions of a ship can be reached by streams from two separate fire stations.

FIGURE 3.4.2 Command organizational structure.



3.5.3.4 Fire Pumps. Fire pumps aboard ships vary greatly in capacity, but they usually are designed to provide much less water than their land-based counterparts. For this reason, augmenting or bypassing the ship's fire pump should not be done without careful consideration. Overpressurization can cause rupture of the piping or result in the operation of the relief valve. Relief valves might be set as low as 125 psi (862 kPa).

3.5.3.5 International Shore Connection. The international shore connection is a device that has the ship's coupling on one end and an adjustable flange on the other end. Shoreside fire departments need to provide the opposite connector, which consists of an adjustable flange on one end and the fire department's coupling on the other. This connection is similar to a standpipe system in a building. It is important that the pressure is regulated to ensure that 150 psi (1034 kPa) is not exceeded. Many fire-main relief valves are set to relieve at 150 psi (1034 kPa) and may discharge into the engine room bilge, adding to stability problems. Departments should consider pressurizing the ship's system to ensure that fire-fighting capabilities on the vessel are maintained. Systems like sprinklers on passenger vessels or car carriers may be critical to prevent the spread of fire. Additionally, the systems may be valuable to protect exposures on board the vessel. When a department is pressurizing a sprinkler or standpipe system, ship engineering personnel should be notified.

3.5.4 Water Sprinkler Systems. Sprinkler systems are not widely used aboard U.S. vessels due to the construction methods employed. The most common use of sprinkler systems by U.S. vessels is for the protection of living quarters, ammunition lockers, public spaces and adjacent passageways, or vehicular decks on roll-on/roll-off vessels and ferries. Their primary function is to protect the vessel's structure and limit fire spread while providing escape routes.

3.5.4.1 Components. Sprinkler system components are similar to those of the land-based systems of the country that constructs the vessel. Exceptions relate primarily to the system's connection to the water supply. The source of water for all shipboard water systems is through the sea suction (strainer), which must be kept free of debris in order to remain effective.

3.5.4.2 System Types. Sprinkler systems are usually of the automatic (wet pipe) or manual (deluge type without detection) type. If the system is charged (wet pipe), a pressure tank maintains the necessary pressure. Piping and tanks are filled with fresh water. Dry-pipe systems are common if the system is subject to freezing.

3.5.4.3 Stability. One of the greatest concerns for all water systems is the effects of the usage of water on the vessel's stability. The amount of time the system has been in operation and the system's flow rate should be obtained immediately upon the arrival of the fire department. The ship's fire plan should be consulted for the location of the system or the zone control valves, or both.

3.5.5 Spray Systems (Exposure Protection). Spray systems are similar to manual sprinkler systems, except that heads or spray nozzles are installed so that their streams are directed at the area to be protected/cooled. Water-mist systems are being found on vessels in many of the places previously protected by halon. In addition, larger systems are available that could take the place of CO_2 systems.

3.5.6 Foam Systems. Foam systems usually are designed to protect only engine rooms or cargo storage areas, or both. The duration of foam discharge is limited, and water usually continues to flow after the foam concentrate supply is exhausted. The ship's fire plan should be consulted for information regarding these factors.

3.5.6.1* Foam Proportioning. Ship systems use various methods of mixing water, foam concentrate, and air to produce foam. The ship's fire plan should be consulted to determine whether the system can be resupplied with foam concentrate or pressure can be augmented.

3.5.6.2 Low-Expansion Foam Systems. Low-expansion foam systems provide vapor suppression with foam blankets that are applied directly to flammable liquids. To be effective, coverage needs to be complete. The quantity of foam needed is calculated according to the total surface area of the area to be protected. These systems are installed in engine rooms as well as cargo areas.

3.5.6.3 High-Expansion Foam Systems. High-expansion foam systems provide vapor suppression by completely filling the volume of the space protected. These systems are installed in enclosed spaces such as engine rooms. Flooding a compartment with high-expansion foam results in reduced visibility for fire fighters.

3.5.7* Carbon Dioxide (CO_2) Systems. Carbon dioxide systems are designed to protect enclosed spaces or portions thereof. They are used to protect cargo spaces, pump rooms, generator rooms, and engine rooms. Some smaller systems are used to protect areas such as paint lockers, galley ranges, and duct systems.

3.5.7.1 Life Hazard. Although CO_2 is a mildly toxic gas, it is extremely hazardous to humans when present in concentrations sufficient to extinguish shipboard fires (upwards of 30 percent by volume, in many cases). Also, visibility usually is obscured during discharge of CO_2. For these reasons, entry into spaces where CO_2 has been discharged never should be attempted without self-contained breathing apparatus (SCBA).

3.5.7.2 Predischarge Warning. Due to the life hazard posed by CO_2, a predischarge warning alarm should be installed in all spaces protected by CO_2 systems. Following evacuation, all doors, hatches, ventilation, and other openings should be closed or covered and all machinery should be shut down. The ship's fire plan should be consulted for instructions on these procedures.

3.5.7.3 System Operation. If the system has not been discharged prior to the arrival of the fire department, the fire plan should be consulted and procedures for discharging agent should be followed carefully. Assistance from the crew should be obtained where available. If the system has not been discharged and personnel are to work in the space, provisions should be made to ensure that the system cannot be discharged inadvertently. In addition to a predischarge warning, discharge delays normally are required for spaces used by personnel to allow for escape. CO_2 systems, like other shipboard fixed fire-protection systems, are difficult to support or augment from outside sources. It is critical that no agent be wasted. Once the involved space has been properly prepared and the system discharged, the on-scene personnel should not enter the space prematurely. Qualified personnel with appropriate testing equipment should be used to test involved areas to ensure that the fire is out before opening the fire scene to outside oxygen sources. Cargo fires can take many days to extinguish with CO_2.

3.5.7.4 System Types.

3.5.7.4.1 Total Flooding. Total flooding systems are designed to protect entire spaces such as engine rooms and cargo holds (larger, manually activated-type systems) or equipment storage areas (smaller, automatically activated-type systems).

3.5.7.4.2 Local Application. Local application systems are designed to apply CO_2 directly to the hazard that is being protected (pumps, motors, electrical equipment).

3.5.7.5 System Storage.

3.5.7.5.1 Low-Pressure Systems. Low-pressure systems are seldom used aboard ship. The advantage of the reduction in the storage space needed is offset by the difficulties of servicing the system. These systems can be found on foreign vessels and ro/ro vessels.

3.5.7.5.2 High-Pressure Systems. High-pressure systems can contain a large number of cylinders (often in excess of 100). They can be located in a designated storage area. Prior to the system's actuation, all cylinder fittings should be checked for tightness, as they might have been connected improperly following servicing. Excessive leaks in system piping can result in the storage room atmosphere becoming unsafe. Precautions should be taken to protect the personnel in this area.

3.5.7.6 Delayed Discharge. If all cylinders are not needed on initial discharge, they can be discharged at appropriate intervals to maintain proper concentration levels. Engine rooms might need all available CO_2, while cargo spaces might need a partial discharge.

3.5.8 Halon Systems. Marine halon systems are used primarily to protect the same types of hazards for which land-based halon is used (e.g., electronics equipment, high-value records, machinery spaces, pump rooms). These systems usually are smaller in size and generally use the same design criteria found in NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems.*

"Pre-engineered" systems are smaller systems that protect areas such as unattended engine spaces on small craft.

3.5.9 Dry Chemical Systems. Dry chemical systems usually are designed to protect galley ranges and duct systems. On liquefied gas carriers, fixed dry chemical systems are installed to protect cargo deck areas and loading station manifolds.

3.5.10 Twinned Agent Systems. Twinned agent systems are used on some ships to protect helidecks or other areas where flammable liquids might be handled. They contain potassium bicarbonate–type dry chemical for knockdown and aqueous film-forming foam (AFFF) for vapor coverage.

3.5.11 Steam Systems. Steam for smothering fires usually is generated by main or auxiliary boilers. To be effective, the steam pressure needs to be 100 psi (690 kPa) or greater. The output of the steam-generating equipment should be 1 lb (0.45 kg) of steam per hour for each 12 ft^3 (0.03 m^3) of volume protected. These systems are not common in the marine industry today but can be found on older vessels. Under no circumstances should steam systems be used on nitrates, sulfates, or explosives. The steam extinguishing systems should be operated only by the ship's crew.

3.6 Ship's Operating Systems.

3.6.1 Introduction. Because a ship is a self-contained unit, its operation is dependent upon and comprised of various internal systems and sources of power. These sources provide power for functions such as movement; electricity; heating, ventilating, and air-conditioning (HVAC); water/sewage; and cargo-handling capability.

Subsections 3.6.2 through 3.6.8 provide the land-based fire fighter with a general understanding of these systems.

3.6.2 Generators. Vessels are equipped with their own electrical generating systems. Electrical power is supplied throughout the ship by various distribution systems. Generators usually are driven by steam turbines or diesel engines. Most ships also have a self-starting emergency generator that supplies vital equipment and emergency lighting; most small vessels [less than 500 gross tons (454 m tons)] and barges have a manually connected emergency power source or none at all. While in port, the vessel might draw its electrical power from shore.

3.6.3 Ventilation. Most ships are a maze of enclosed metal spaces that need to be provided with air exchanges on a regular basis. Exchanges usually are accomplished by mechanical systems that can be similar to those in land-based structures.

Usually, the initial procedure during a ship fire is to shut down all ventilation systems during the containment phases of fire fighting.

3.6.4 Fuel Systems. Fuel oil systems aboard ships include tanks, piping, pumps, and associated equipment. The associated equipment is used for heating, straining, centrifuging, measuring, and burning fuel oil. The fuel oil transfer system can be used by the ship's personnel to effect vessel stability and trim by transferring fuel from tank to tank.

3.6.5 Communications Systems. Large ships are dependent on communications for their efficient operation. Systems can include electric and electronic telephones and voice-powered telephones. Voice tubes are sometimes provided between a ship's wheelhouse and engine room for use in an emergency. Portable radios commonly are used by the ship's personnel throughout the vessel.

3.6.6 Cargo Handling. The main purpose of a merchant ship is to transport cargoes safely and quickly from one place to another. Types of cargoes vary and necessitate different types of ship and shore loading and discharging mechanisms. Some types of cargo-handling gear include winches and booms, derricks, cranes, floating cranes, roll-on/roll-off ramps, shoreside gantries, and pumping systems. Trained personnel are needed to handle ship cargoes. The ship's cargo-loading manual may be needed if cargo has to be off-loaded or shifted during fire-fighting operations. This manual is required to ensure that the vessel's equilibrium is maintained. Failing to use the manual during off-loading or shifting cargo could cause serious structural damage to the vessel or could cause stability problems. The master of the vessel should be consulted prior to moving any cargo.

3.6.7 Mooring and Anchoring Systems. Vessels are secured to docks with various configurations of mooring lines and wires. These mooring systems need to be monitored because of changes in the tide and current. Broken moorings can set the vessel adrift, resulting in personnel becoming stranded on the burning vessel and separated from their shoreside supply lines.

Anchors are connected to vessels by heavy chain or cable, which is manipulated through a device known as a *wildcat/windlass.* Anchoring is a specialized evolution of seamanship and necessitates proper training to be performed safely and successfully.

3.6.8 Inert Gas Systems. The design and purpose of the inert gas system is to exclude oxygen or air from the void tank spaces of liquid bulk carriers. These gases usually are manufactured on board the ship. The inert gas can present a hazard to fire fighters.

Chapter 4 Vessel Stability

4.1 Introduction. In combating a fire aboard a vessel, fire fighters should give attention to the volume of water used for extinguishment and its effect on the stability of the vessel. Water applied to a vessel fire can jeopardize the stability of the vessel and the safety of the personnel on board. The application of water should be monitored carefully, and water should be removed in a timely and efficient manner. It is recommended that the incident commander have a basic understanding of this chapter. However, the incident commander is urged to consult the vessel's master, engineer, and other experts to determine how much water can be used safely. How and when water is added or removed from the vessel is critical.

4.2 Vessel Stability and Equilibrium.

4.2.1 General. Stability is the tendency of a floating vessel to return to an upright position when inclined from the vertical by an external force. If the vessel returns to or remains at rest after being acted upon, it is in either stable or neutral equilibrium. If it continues to move unchecked in reaction to the external force, it is in unstable equilibrium. An unstable vessel, therefore, is one that, after being inclined, if it does not find a point of stable or neutral stability, continues to incline until it capsizes. Throughout an incident, it is desirable to maintain vessel stability and to minimize list.

4.2.2 Initial Stability. The ability of the vessel initially to resist heeling from the upright position is determined by its initial stability. The vessel's initial stability characteristics hold true only for relatively small angles of inclination. At larger angles, defined as those over 10 degrees, the ability of the vessel to resist inclining movements is determined by its overall stability characteristics.

4.3 Typical Vessel Conditions. This chapter generally addresses stability with respect to vessels that are floating, that have hulls that are intact, and that are moored or in protected waters. Usually, these conditions exist during the beginning stages of an incident. Stability and weight distribution considerations are relatively simple in these situations.

If, for instance, an explosion has ruptured the hull or the vessel has run aground, the situation will become more complex. These more complex situations can occur singly or in combination and include vessels that are in the following conditions:

(1) Aground
(2) Damaged (holed) with free communication to the sea
(3) Under way with extensive free surface
(4) In dry dock, graving dock, synchrolift, or a similar situation

Unquestionably, expert advice should be obtained any time the stability of the vessel is in doubt. A complete list of consulting resources, including those for vessel stability, should be compiled and maintained. The vessel's crew, who should be most familiar with the vessel's stability situation, might not always be available or able to provide an adequate assessment of the situation. *(See Section 4.10.)*

4.4 Center of Gravity. The center of gravity of an intact vessel is the location of the point where the sum of all the weights in the vessel is equal to zero with respect to any axis through this point. The vertical downward force of gravity acts through this point. Knowledge of the center of gravity and its relationship with the vessel's center of buoyancy and righting arm are key factors when determining and controlling vessel stability.

The concept of center of gravity is essentially the same for a vessel as for other mobile equipment, such as an aerial ladder. In essence, the weight of the particular piece of equipment is considered to be concentrated at that point. As an aerial ladder is raised, the unit's center of gravity rises and is counteracted by the inherent weight of the vehicle and its supporting outriggers. Similarly, a vessel's center of gravity also rises as weight is placed higher in the vessel. It differs from an aerial ladder in that it is unable to provide external support mechanisms (i.e., outriggers) due to the water around it.

Vessels, therefore, suffer a loss of stability as water utilized in fire fighting accumulates above the original center of gravity. This loss is particularly significant with regard to vessels with large superstructures, such as passenger ships and car carriers. The higher the weight, the more detrimental is the effect. If this vulnerability is not properly understood and controlled, the consequences can impact all fire-fighting efforts severely. It is an integral part of overall strategy.

4.4.1 Free Surface Effect. Free surface, for the purpose of fire fighting, is defined as the tendency of liquid within a compartment to remain level as the vessel is transversely inclined or heeled, provided the compartment:

(1) Is intact
(2) Is partially filled
(3) Allows the liquid to move unimpeded from side to side

The free surface effect of loose water anywhere in the vessel impairs stability by raising the center of gravity in an apparent or virtual sense.

4.4.2 Free Surface Critical Factors. If the vessel is listing or develops a list, liquid flows to the low side of the compartment and results in an athwartship shifting of weight. This movement causes the apparent height of the center of gravity to rise, impairing stability. The critical factors of free surface are the surface area of the liquid and the breadth of the compartment. The length of the compartment is much less a factor than its width. For fire-fighting stability considerations, a liquid's free surface effect is not related to either the liquid's depth or its location within the vessel. Whether the liquid is high or low, on or off centerline, or forward or aft, the reduction in stability due to free surface is the same. However, it is critical that the effect on the overall stability of the vessel be kept under consideration. A weight added high in the ship not only raises the center of gravity due to free surface but also raises it due to the height above the keel.

4.4.3 Free Surface Reduction. Pocketing is the effect of liquid contacting the top of the compartment or exposing the bottom of the compartment. It reduces the breadth of the free surface area and therefore has a beneficial effect on stability. Similarly, solid fixed objects projecting through the surface (surface permeability) impede the liquid's movement and are of some benefit. Since the positive effects of pocketing and surface permeability are difficult to determine, they should be considered to be an extra margin of safety in free surface assessments.

4.4.4 Combined Effects. The strongest threat to vessel stability from water-induced fire-fighting efforts is encountered when the water is both:

(1) Confined high in the vessel
(2) Free to travel significant distances across the beam

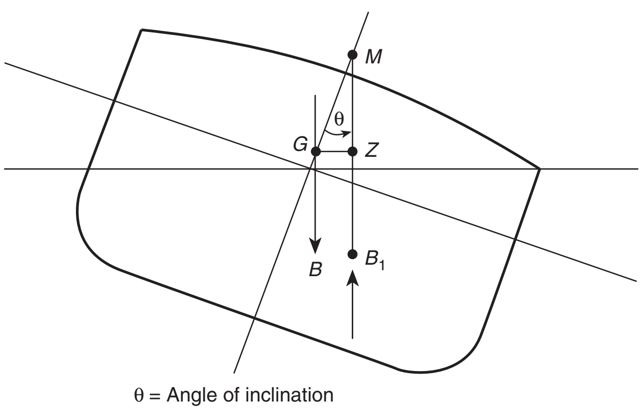
The consequences of these combined effects can be devastating. Unfortunately, they sometimes trigger other serious problems. Once the vessel begins to heel, this domino effect can quickly compound an already aggravated situation.

4.5 Center of Buoyancy. If the water that is displaced by the vessel is considered as a single homogeneous unit, the center of the displaced volume of water is considered the location of the vessel's center of buoyancy. This is the geometric center of the underwater form of the vessel. The vertical upward force of buoyancy acts through this point.

4.6 Righting Arm. The perpendicular distance between the force of gravity (through the center of gravity) and the force of buoyancy (through the center of buoyancy) is called the *righting arm* or *righting lever*. It generally is calculated at 10-degree intervals of list for several different load conditions of the vessel.

4.7 Metacentric Height. The true measure of a vessel's initial stability is called the *metacentric height* or GM of the vessel (*see Figure 4.7*). It is simply a geometric relationship between the center of gravity (G), the center of buoyancy (B), and the vessel's righting arm (GZ) for a given angle of inclination. After listing, B_1 is the new center of buoyancy.

FIGURE 4.7 Center of buoyancy.



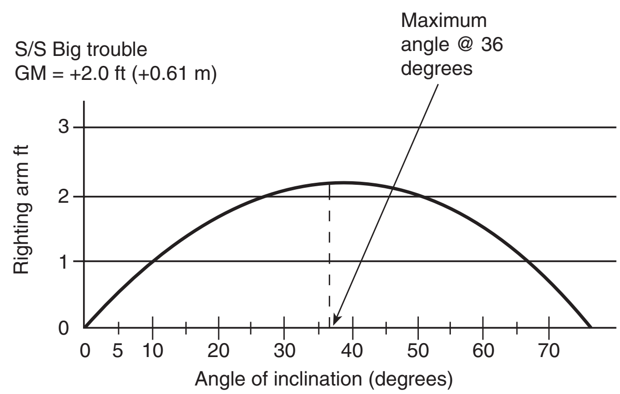
If M (metacenter) is above G, GM is positive. If M is below G, GM is negative. A positive GM indicates that the vessel will tend to float upright and will offer resistance to an applied outside force. A negative GM indicates that the vessel is initially unstable and will cease to float upright when even the smallest outside force is applied. An initially unstable vessel might list only at a given angle and come to rest in a state of stable equilibrium. If the negative GM is great enough, the vessel will not come to rest before capsizing.

This relationship between the vessel's stability and GM is only accurate at small angles of heel (below 10 degrees). As list increases, the overall stability of the vessel is the determining criterion. It is interpreted through the stability curves that are normally found in the vessel's trim and stability booklet, generally obtained from the captain. During cargo loading and unloading, accurate values of the ship's stability are rarely maintained.

4.8 Stability Curves.

4.8.1 The ship's officers should identify the curve that most closely represents the ship's current condition of loading. If no curve is considered applicable, the curve showing the minimum stability condition should be determined. If no curves exist, the incident commander should depend upon the ship's officers, USCG, and others for guidance. The graphic curves depicting the vessel's calculated righting arms at incremental angles of heel are called the vessel's *stability curves*. These curves reveal the overall stability characteristics of the vessel. They are extremely important, since they quickly reveal the maximum righting arms for the vessel at different conditions of loading (different values of GM). The maximum righting arm and, more important, the angle of inclination at which it occurs, is the primary indicator of danger where the stability of the vessel is in serious doubt. A fictitious example of a partially loaded vessel with +2 ft (+0.61 m) GM is depicted in the stability curve shown in Figure 4.8.1.

FIGURE 4.8.1 Stability curve.



It should be noted that the maximum righting arm attained in this condition is at an approximate inclination angle of 36 degrees. Generally, this maximum angle indicates the point at which the edge of the weather deck becomes submerged. At this point, stability drops off rapidly. A vessel suffering a permanent list would be in imminent danger of capsizing long before this angle was reached.

4.8.2 The critical angle of list is the point at which it can be assumed that critical events will occur. It is not a point that remains constant in all cases. In some vessels, it could be as much as $^1/_2$ of the maximum righting arm. In another case, it could be substantially less than this value. The critical angle depends on the conditions that exist on a vessel at the time of a fire. It can be determined only by qualified personnel as a result of stability calculations combined with professional judgment.

4.9 Vessel Stability Concerns. The most important concern regarding vessel stability is the control of the vessel's list. The inability to maintain the vessel at a reasonable degree of transverse levelness (side to side) will seriously impact all fire-fighting operations.

4.9.1 Fire-Fighting Factors Affecting Stability. The introduction of large amounts of water into the vessel as a result of fire-fighting operations is probably the most critical factor affecting vessel list. Other factors include the following:

(1) Intentional flooding of compartments
(2) Movement of personnel and equipment through watertight doors

4.9.2 Stability Factors Affecting Fire Fighting. As a vessel's list increases, so do the concerns related to fire-fighting activities. As the vessel heels, poor footing on slippery decks can slow or stop fire-attack teams. It can be difficult to apply and maintain a foam blanket. Other concerns include the following:

(1) Possible closure problems with automatic fire doors
(2) Increased chance of flammable liquid spills
(3) Strain and possible failure of mooring lines
(4) Restriction and loss of vessel access/egress
(5) Damage or injury from shifting of loose objects
(6) Problems with fixed dewatering drains and suctions
(7) Loss of vessel machinery due to excessive sustained list

4.9.3 Vessel Factors Affecting Initial Stability. In 4.2.2, the stability of the vessel is described as its ability to resist heeling from the upright position at small angles of inclination. This ability, which is a function of the vessel's GM, can diminish rapidly as the incident progresses and depends on current vessel conditions such as the following:

(1) The free surface status of all liquids aboard
(2) Whether or not the hull is intact
(3) The flatness of the hull bottom if it has run aground
(4) Whether the double bottoms are empty or full
(5) The integrity of watertight boundaries if flooded

4.9.4 Internal Factors Affecting Overall Stability. As the vessel destabilizes and list increases to larger angles of inclination, other factors can aggravate the vessel's worsening condition. These include the following:

(1) Shifting of loose objects or bulk dry cargo such as grain or coal
(2) Flooding from unsecured hull openings such as portholes
(3) Movement of items such as unsecured cargo, machinery, or stores

4.9.5 Factors Affecting Underway Operations. The self-propelled movement of a destabilized vessel within a confined waterway can be hampered by operational difficulties. If the vessel is suffering a large list, trimmed by the bow, or drawing a draft that is too tight for the available water, operational concerns should include the following:

(1) The steering system might function improperly
(2) The vessel machinery might not function at large lists
(3) Maneuvering control might be lost due to the vessel's proximity to the bottom
(4) The free surface area might cause the vessel to flop from side to side

4.9.6 External Factors Affecting Overall Stability. Planning for the impact of external factors might help to minimize their negative effects. Concurrently, planning for the positive effects might help to maximize some benefits. External factors include the following:

(1) Adjacent structures, such as piers and wharves
(2) Mooring lines, if the vessel is listing away from the structure
(3) Vessel contact with the bottom due to tide changes
(4) Contour of the bottom beneath the vessel if contact occurs
(5) Composition beneath the vessel, such as mud or rock
(6) Accumulations of snow or ice on high areas
(7) State of the surrounding sea
(8) Action of passing vessels (e.g., wake, suction effect)
(9) Unusually intense high winds, if in a significant sailing area

4.10 Basic Stability Information and Resources.

4.10.1 Stability Resources. An incident commander who possesses a basic understanding of stability concepts and concerns should be able to draw upon the available information resources prior to and during an incident. For purposes of this chapter, information resources are divided into consulting personnel and consulting documents. Stability equipment resources are discussed in Section 4.11.

4.10.1.1 Consulting Personnel. Prior to an incident, a regional inventory of stability advisers should be compiled. These individuals or agencies vary, depending on locale, except for the identification of the COTP. The COTP offers assistance to all ports within his or her respective zone throughout the United States. The COTP or the COTP designee normally is available during a large-scale incident to provide stability advice. The COTP also can help access and coordinate various federal resources and agencies if the ultimate scope of the situation necessitates additional expertise or equipment, or both. Stability advice also can be obtained from marine-related personnel, including the following:

(1) Vessel officers (master, chief mate, and chief engineer)
(2) Vessel operators/owner representatives, such as the port captain
(3) Pilots or docking masters
(4) Harbormasters or port authority representatives
(5) Salvage masters
(6) Officers from other vessels
(7) Marine consultants
(8) Naval architects
(9) Maritime academies
(10) Marine fire-fighting schools
(11) The National Cargo Bureau

4.10.1.2 Consulting Documents. It is prudent for response organizations to maintain vessel information. This should include information on vessels that visit a port regularly or occasionally, since it could be difficult to gather information during an incident. The preferred approach is to be familiar with the vessel's onboard documentation prior to an event. General information and copies of vessel documents might be available from the owner or operator if information is needed during an incident. In an emergency, however, some firms might be able to send information via facsimile or Internet. Documentation and other information that might be helpful with stability considerations include the following:

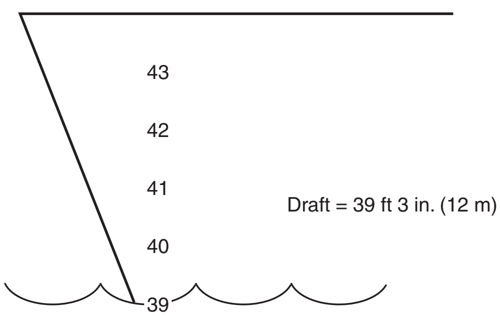
(1) Vessel trim and stability booklet or similar document
(2) Vessel immersion factor in tons per inch (tpi)
(3) Vessel general arrangement plan
(4) Vessel capacity plan
(5) Vessel fire control plan
(6) Vessel docking plan
(7) Vessel cargo plan
(8) Calculator used to calculate trim and stress factors
(9) Computer or loadmaster used for stability calculations

The vessel trim and stability booklet should be located early in fire-fighting operations. The vessel's crew is trained in applying the information in the booklet. The Coast Guard's Marine Safety Center can be consulted on utilization of the booklet.

4.10.2 Primary Stability Information. Basic stability data should be gathered during the initial stages of an incident. The methods or sources utilized to obtain the data often affect accuracy. Information should always be verified.

4.10.2.1 Vessel Drafts. Most large vessels have draft marks that appear as vertical scales on both sides of the hull at the bow and the stern. They usually are incremented in either feet or meters, with the base of the number being the increment (zero) line. Large ships and barges also have draft marks midship on both sides. For example, on American ships, the numbers are 6 in. (152 mm) high with 6 in. (152 mm) spaces between them. The base of each number indicates an even 1 ft (0.3 m) of draft; if the water covers half of a number, the ship's draft is equal to that number of feet plus 3 in. (76 mm) (*see Figure 4.10.2.1*). All drafts should be visually read and documented as soon as possible in order to establish a baseline for future reference. It is important to be able to compare the initial marks to those recorded later during the operation. This comparison will allow technical advisors to determine what effect operations are having upon the stability of the vessel.

FIGURE 4.10.2.1 Draft marks.



For various reasons, automatic draft gauges for obtaining draft readings remotely should be considered inaccurate. If possible, automatic readings should be avoided as the primary source of draft information. Such readouts should be considered to be a double check of visual hull observations.

4.10.2.2 Vessel List. The angle of transverse inclination normally is obtained while aboard by reading the vessel's inclinometer. Most vessels have an inclinometer in the wheelhouse on the bridge deck. Some vessels, particularly large ones, have additional inclinometers at other locations, including the engine room control flat, cargo control room, master's office, chief mate's office, and chief engineer's office, or at a prominent centerline location on the main deck. As in the case of draft readings, a baseline reading should be established as soon as possible for monitoring purposes.

4.10.2.3 Vessel Status. Tank and cargo status should be determined. As mentioned previously, if cargo operations were in progress, the vessel could be considerably more vulnerable to stability problems. This is especially true of bulk carriers and even truer of liquid bulk carriers, due to the free surface effect. The location and status of any flooded compartments within the vessel also should be ascertained at this point.

4.10.2.4 Available Depth of Water. The minimum depth of water at the shallowest location beneath the vessel should be determined. The vessel's current deep draft should be subtracted from the water depth to obtain the vertical distance between the vessel and the bottom. Tidal changes also should be incorporated if applicable.

4.10.2.5 Type of Bottom Material. If the vessel contacts the bottom, the nature of the bottom can be a critical factor. For example, the difference between a mud and a rock bottom is extremely significant. This condition should be determined as soon as possible, and accuracy should be ensured.

4.10.2.6 Water Flow. The amounts of water being put on board the vessel and the amount anticipated for the hours to come should be calculated. It might be convenient to determine rates in tons per hour, instead of gallons per minute, since stability calculations probably will be worked in tons. *(See 4.11.1 and 4.11.2.)*

4.10.3 Secondary Stability Information. If the stability situation is in doubt, the initial assessment outlined in 4.10.2 should be followed immediately by a secondary information flow.

4.10.3.1 Hull Openings. All direct hull openings, such as portholes or cargo loading doors, that could allow water to pour aboard in the event a serious list occurs should be assessed.

4.10.3.2 Dewatering Capacity. The vessel's fixed dewatering capacity and power supply potentials should be determined. It probably is beneficial to convert all rates to tons per hour. *(See 4.11.1 and 4.11.2.)*

4.10.3.3 Watertight Potentials. Watertight areas and capabilities of the vessel with regard to flooding resistance should be determined. Special attention should be given to watertight doors and closing mechanisms.

4.10.3.4 Mooring Potentials. The possible dangers to personnel in the event mooring lines fail as a result of severe strain from the vessel listing away from the pier or wharf should be assessed. The alternatives that are available with the mooring system should be determined, and the consequences should be understood.

4.10.4 Vessel Aground. If the vessel is aground or is in danger of contacting the bottom, other information is needed and could include the following:

(1) Slope of ground beneath vessel
(2) Shape of vessel's hull bottom
(3) Proximity of passing deep-draft traffic
(4) State of sea forecasts
(5) Hull stress considerations

4.11 Dewatering.

4.11.1 Water Weight. Aboard most large vessels, weight is measured in long tons [2240 lb (2034 m tons)]. A gallon of salt water weighs about $8^1/_2$ lb (3.8 kg), while fresh water weighs slightly less. This weight is equivalent to approximately 264 gal (999 L) per long ton. It should be noted that these figures apply to U.S. gallons. Imperial gallons (1.1 U.S. gal) are used aboard British, Canadian, or other vessels and should be adjusted accordingly.

4.11.2 Water Flow. A $2^1/_2$-in. (64-mm) attack line delivering 250 gpm (9461 lpm) adds approximately 64 tons (58 m tons) of weight to the vessel each hour. A $1^1/_2$-in. (38-mm) line can deliver that quantity, or approximately 25 tons (22.7 m tons) per hour.

4.11.3 Vessel Fixed Pumps. Vessels usually have bilge pump capability for most machinery spaces and large compartments that are situated in the lower parts of the vessel. Some of these spaces can include the following:

(1) Cargo holds
(2) Main engine room
(3) Boiler room
(4) Shaft alley area
(5) Cargo pump rooms
(6) Forward machinery space
(7) Thruster rooms

4.11.3.1 Fixed Pump Suctions. Vessel bilge pumps usually are attached to fixed piping and, therefore, have no flexibility regarding movement and positioning of the pumps' suctions. However, these pumps often have the flexibility to "cross over" and draw from a varied number of fixed suctions. As a result, the fixed system is limited to pumping only water that settles into the lower areas of the vessel and is susceptible to clogging. The capacity of fixed pumps needs to be determined, since they might hold less than 500 gpm (18,931 lpm). Water that accumulates in upper spaces needs to be removed by some alternate means.

4.11.3.2 Fixed Pump Power. Some older steam vessels have steam reciprocating bilge pumps, but most have electric bilge pumps that are powered by the vessel's generators. If the vessel's main generators fail, the pumps probably will be useless. Emergency generators often are not able to supply sufficient power to operate both fire and bilge pumps simultaneously. If electrical power has been secured in the vicinity of fire-fighting operations (due to shock hazards), the vessel's pumps might not be available for use.

4.11.4 Vessel Portable Pumps. Although some vessels have a few small portable diaphragm pumps that run on compressed air, most vessels provide limited portable pump capability.

4.11.5 Vessel Drainage System. Drains located on board most vessels are designed to gravity-drain most spaces that are above the vessel's normal waterline through the hull into the sea.

Spaces that are at or below the waterline often are drained into the vessel's bilges. Whether they drain overboard or into the bilge, these drains (called *scuppers*) are generally small in diameter, making them vulnerable to blockage by debris that would almost certainly be present throughout fire-fighting efforts.

4.11.6 Swimming Pools. If the involved ship has swimming pools, water should be removed from pools, beginning with the highest pool.

4.11.7 Toilet. If there is a sanitary drain available at the floor level, the fixture (toilet, shower, or bidet) should be removed to allow the water to flow into the holding tanks, which are well below the waterline. The resultant shift of weight lowers the center of gravity.

4.11.8 Portable Pumps Brought on Board. Arrangements for vessel dewatering should be made without delay. Moving portable pumps on board necessitates hoisting equipment and numerous personnel to assist with positioning. Dewatering considerations should be automatic and should be addressed without delay if the fire is not suppressed quickly. Sources of portable pumps include the following:

(1) The COTP
(2) Industrial pump suppliers
(3) Salvage companies
(4) U.S. Navy installations
(5) USCG strike teams
(6) Pollution cleanup contractors

4.11.9 Portable Pump Types. Pumps are powered by a variety of methods, including electricity, air, gasoline, and water. Of all pumps, the water eductor or ejector pump is probably one of the most efficient devices to position within the vessel. It works on the principle of a venturi and has no moving parts. These units are extremely lightweight and need minimum supervision once they are operational. However, hoses on the discharge site need to remain clear, or water can back up into the space being dewatered.

4.11.10 Cutting of Holes. In areas of the superstructure where the metal is relatively thin, it might be preferable to cut holes to allow water to run out. Cutting holes in vessels can be extremely dangerous. Holes never should be cut without thoroughly reviewing the consequences and obtaining permission from the appropriate authority; generally, this authority is the ship's master. Exothermic torches can outperform oxyacetylene torches in fire and flooding conditions.

4.12 Stability Analysis and Monitoring.

4.12.1 Critical Angle of List. Once the vessel status is determined as part of the primary information (*see 4.10.2*), the vessel's GM should be computed for its current condition. The GM should be used in conjunction with the vessel's trim and stability booklet to determine the critical angle of list for the vessel's current condition. *(See Section 4.8.)*

4.12.2 Vessel Drafts. Drafts should be monitored at least every $^1/_2$ hour. If the vessel is listing, the drafts on the low side of the vessel will be greater than those on the high side. For this reason, it is prudent to use the average of the two sides. Also, the midship draft should be exactly halfway between the forward and after drafts. If the draft is more than 6 in. (152 mm) off this halfway point, it could be an indication that the hull is being subjected to severe stress due to hogging and sagging. The vessel's drafts should be monitored and recorded for at least 4 hours after discontinuing water flow into the vessel to ensure there is no change in vessel stability.

4.12.3 Tons per Inch Immersion. The trim and stability booklet for a large vessel generally includes a hydrostatic table that describes the vessel's tons per inch (tpi) immersion factors for various drafts. These figures represent the weight, in tons, necessary to sink the vessel 1 in. (25 mm). Since this refers to the vessel's mean sinkage, each inch of sinkage directly corresponds with each inch of draft at the midship draft marks. This fact should be used to visually confirm the calculated weight of water being placed aboard the vessel.

4.12.4 Vessel Listing at Pier. Generally, it is preferable to have the vessel list away from the pier or wharf so that list can be monitored as it progresses. This might require slacking the mooring lines and adjusting vessel access ramps. The alternative, to allow the vessel to lean against the structure, would not only interfere with the list monitoring but could also lead to damage to both the vessel and the adjacent structure. The vessel's draft probably will increase on the side of the list. This fact, combined with the generally deeper water away from the shore-based structure, also suggests a list away from the pier as more appropriate and safer than a list toward the pier.

4.12.5 Increase of Draft Due to List. Due to the relative flatness of most vessel bottoms, the draft increases as the vessel lists. An approximate value of the increase is equal to $^1/_2$ the vessel's breadth times the sine of the angle of list. The formula is as follows:

$$\text{Increase in draft} = \frac{\text{beam}}{2} \times \text{sine angle of list}$$

For example, for a vessel with 92 ft (28 m) beam listing at an angle of 8 degrees:

$$\left(\frac{92}{2}\right) \times (\text{sine 8 degrees})$$
$$= 46 \times (0.1392)$$
$$= 6.4 \text{ ft (2 m) increase in draft}$$

4.13 Stability Tactics.

4.13.1 Vessel List. Generally, the prime stability concern of an incident commander is to minimize the vessel's list. Control of the list can be accomplished through a variety of tactics and depends on the cause(s) of the list and the particular circumstances involved.

4.13.2 Causes of List. The two basic causes of vessel list are one of the following:

(1) A negative GM
(2) An off-center position of the vessel's center of gravity

The list can be the result of either one of the causes or both causes in combination. If negative GM is the cause, any transfers of weight within the vessel should be very carefully considered before being performed. It is possible that a transverse shifting of weight to correct list due to negative GM could result in a worse situation.

4.13.3 List Correction. If the list is due solely to the accumulation of water through fire-fighting efforts, then the preferred tactic for corrective action is to remove the water. Corrective measures are more complex for other causes of list, such as progressive flooding or large weight shifts. The following outlines a sequence of general actions to limit and improve an impaired stability situation and its associated list:

(1) Determination and establishment of flooding boundaries
(2) Removal of water from partially flooded areas (removal from free surface areas first)
(3) Jettison of topside weight
(4) Complete removal of water from solidly flooded areas
(5) Transfer of weight as appropriate (usually liquids)
(6) Addition of weight as appropriate (counterflooding)

(See Section 4.4.)

4.13.3.1 Establish Flooding Boundaries. Boundaries should be established to enclose the area subject to flooding. Vertical as well as lateral perimeters should be planned. Action should be swift and efficient.

4.13.3.2 Free Surface Reduction. There are two basic ways to reduce free surface:

(1) The flooded compartment is filled completely.
(2) The flooded compartment is emptied completely.

Filling might be a faster, more convenient approach, but it increases the vessel's weight and draft and possibly increases the list. Emptying the compartment is far more desirable.

4.13.3.3 Weight Removal. Removal of liquid and solid weights from higher locations on board should lower the center of gravity, improve stability, and help improve the list.

4.13.3.4 Weight Transfer. Transfer of weight is normally accomplished with liquids, since the movement of large numbers of solid objects can be impractical. Methods of transfer can include pumping and gravitating. Weight transfer is not recommended if free surface is the cause of the list or a significant factor in the list.

4.13.3.5 Weight Addition. Similar to transfer, liquid weight addition usually is the most practical. This usually is accomplished through counterflooding the compartment(s) with seawater. Counterflooding should never be used if free surface is the cause of the list. Counterflooding should always start with the lowest spaces available, such as double bottoms or low water tanks. The inherent problems of free surface effect, and the additional weight, make counterflooding or counterballasting a last resort.

4.13.4 Scuttling or Beaching. If it becomes apparent that the vessel is going to be lost due to capsizing or because of a fire too extensive to control, the only alternative might be to sink (scuttle) the vessel. This decision is made by the COTP in conjunction with involved parties. Under these two circumstances, it might be necessary to sink the vessel at the pier by overall flooding. If time allows, it is preferable to have the vessel towed to a suitable beaching ground. It then can be sunk awash without damage to the hull from a rocky bottom and without creating an obstruction to normal shipping.

Chapter 5 Organizational Resources

5.1 Vessel Owners and Operators. There are many different combinations of vessel owners and operators. Owners and operators range from individuals to small companies to large shipping lines. There can be many owners or only one. Some owners are involved with the daily operation of the vessel; others are far removed from such activities. Some owners are also the operators, but this usually is not the case. Sometimes vessels are chartered or leased many times over, further complicating the situation. Most of the time, the owner or operator does not own the cargo, and there can be many different cargo owners. It can become very difficult to determine who owns or operates the vessel, who represents these individuals, and who has the authority to make decisions concerning the protection and safety of the vessel.

The master of the vessel usually represents the owner or operator but sometimes does not have the authority to make all decisions. Because most owners and operators do not have offices/agents in all of the vessel's ports of call, many large organizations send owner or operator representatives to a fire scene. This representative, sometimes called the *port engineer* or *port captain*, usually has some technical training, experience in the particular trade of the vessel, and the authority to make decisions and spend money.

Besides decision making and technical expertise, the owner or operator usually can provide funding. It is the owner or operator, and eventually the owner or operator's insurance companies, who usually bear much of the cost of the fire-fighting operation, such as for fire-fighting agents, tugs, pilots, cranes, barges, divers, and pollution cleanup.

5.2 Marine Terminal Owner or Operator. Marine facilities have a variety of personnel that may be of assistance during an emergency. These personnel can provide support services similar to a city public works department. Some facilities may have fire brigades that may provide assistance in operations or support.

The owner of the marine terminal is sometimes also the operator of the terminal. However, often the operator leases the property and equipment from the owner (the city, port authority, or private corporation), and the owner is removed from the daily operation. In either case, determining who owns or operates a marine terminal is usually not as much of a problem as it is in the case of a vessel because the terminal owner/operator office usually is located at the terminal.

Marine terminal owners and operators often can supply many resources to the fire-fighting operation. They can provide security by keeping unwanted visitors off the terminal during a fire, and they can provide communications by using fixed and portable systems on the terminal. They can supply cargo-handling equipment (e.g., forklifts, trucks, and cranes) that often are needed to move and protect threatened cargo. The owner or operator also can provide a location for a command post, fire-fighting hoses and water, and sometimes foam, dry chemical, and a fire-fighting brigade. The fire-fighting equipment available on the terminal usually can be found in the Coast Guard Fire-Fighting Contingency Plan.

5.3 Terminal Fire Brigades. Some large marine terminals, such as bulk oil terminals, and some large shipyards maintain private fire brigades on their properties. These brigades are trained specifically to fight the type of fires that could occur on the property they protect. They can be a great source of specific information concerning the cargoes and hazards on their particular property. They also can be the source of additional fire equipment and extinguishing agents, such as foam and dry chemical.

5.4 Shipping Agents. Shipping agents are the port's commercial representatives of the vessel owner or operator. The agent schedules pilots, small repairs, and vendors; notifies federal agents of the vessel arrival; makes arrangements for berths, line handlers, fuel, water, and electricity; and ensures that all the needs of the vessel and crew are met while in port.

Some vessel operators, such as large shipping lines, act as their own shipping agents, but shipping agents are not vessel owners or operators. Shipping agents always know the identity of the owners and operators. They are in direct contact with the person or persons who control the operation and movement of the vessel and, therefore, often can obtain permission decisions from the appropriate person.

5.5 Pilots. Most major ports in the United States have docking pilots and channel pilots. Docking pilots normally moor and unmoor large vessels with the assistance of tugs. They sometimes work for, or are associated with, a tug company and navigate the vessel to or from a prearranged location just off the dock and in the channel. The channel pilots navigate large vessels from and to the sea buoy at the offshore end of the channel, usually without the assistance of tugs.

Pilots usually have very reliable information concerning the arrival and departure of vessels in the port. They also have a great deal of knowledge and experience with respect to local weather and currents. Large vessels normally are moved within the port by pilots.

5.6 Port Authorities. Port authorities are federal, provincial, state, regional, or local government agencies, or a combination thereof, that manage the operations of the ports under their jurisdiction. They often own or operate terminals in the port and, therefore, can provide many of the same resources as do other terminal owners and operators. Because of their legal authority over the port, they play a large role in the overall planning and coordination of vessel fire protection.

5.7 Tug, Towing, and Barge Companies. Tug, towing, and barge companies can provide services that are vital during a vessel fire. Some operate tugs that have the horsepower and equipment to move large vessels within the port. These tugs could be needed to move a burning vessel to a safer or more accessible area of the port. They also could be needed to tow a burning vessel from offshore to a safe harbor, or the reverse. Some operate deck and tank barges, which might be needed as a platform from which to fight a fire or transfer fuel from a burning vessel. Some of these companies provide all these services.

Another service some of these companies provide is fire-fighting support. Many, but not all, tugs are equipped with fire pumps or monitors, or both, to provide a water stream from the waterside. The type of equipment that a company operates and its fire-fighting capability usually are found in the USCG Fire-Fighting Contingency Plan.

5.8 Fire-Fighting Agent Supplies. Beyond the usual and well-known commercial suppliers, military installations and other marine terminals often can be the source of fire-fighting agents, especially foam and CO_2. Shipyards, ship chandlers, airports, and petrochemical facilities also might be able to supply some fire-fighting agents.

5.9 Cargo Handlers. In many areas, longshoremen load or unload much of the cargo entering or leaving the port on vessels. An exception is bulk liquid cargo, which usually is loaded or unloaded by the vessel's crew and marine terminal personnel. Some longshoremen work for a stevedoring company, while some work for the marine terminal. If containers or cargoes need to be off-loaded, appropriate arrangements need to be made.

5.10 Marine Construction Companies. Marine construction companies can provide expertise in the construction of such structures as piers, wharves, bridges, and marinas. They usually operate cranes on barges that can be towed throughout the port to provide lifting capability from the waterside. They could be used to clear damaged or undamaged structures and to construct temporary piers, wharves, or bridges. They usually are sources of underwater welding.

5.11* Marine Chemists. Every marine incident has the potential to be a confined space incident. Numerous locations on board a vessel can have hazardous atmospheres, including oxygen deficiency. There are numerous documented cases of stevedores and vessel's crew being overcome by fumes or reduced oxygen because of a chemical reaction. During fire incidents, it must be assumed that any compartment that is not normally designed for continuous human occupancy may contain some form of hazardous atmosphere. Vessels will not normally have a confined space program in place that is similar to that found in industrial situations.

As a result of normal construction and design, vessels usually contain many enclosed, poorly ventilated spaces. The atmospheres in these spaces often are tested by a marine chemist to protect the people entering them. They test these atmospheres for the content of oxygen and harmful, explosive, and flammable vapors. This information is very valuable during a vessel fire when deciding which vessel compartments need to be protected. It also is necessary during overhaul at regular intervals to protect the people working in the enclosed space. The vessel's crew also might have some limited gas detection equipment and ability.

5.12 Marine Surveyors. Marine surveyors usually are private consultants who survey damaged vessels and recommend needed repairs. They have technical expertise and local knowledge in vessel construction and repair. There are some large marine surveying companies, but most surveyors are independent and self-employed. They are hired by vessel owners and operators to ensure that the vessel gets the proper, most economical repair.

5.13 Marine Salvage Companies/Salvors. These companies salvage severely damaged or sunken vessels. They usually own or operate very sophisticated equipment, such as floating cranes, inflatable lifting bags, deep-diving equipment, and underwater welding and cutting equipment. If a vessel is sinking and needs to be kept afloat, or has sunk and needs to be raised, these companies have the expertise and equipment to accomplish the job. The U.S. Navy Supervisor of Salvage (who can be contacted through the COTP) also has this type of expertise and equipment.

5.14 Law Enforcement Agencies. Various government agencies have law enforcement duties in the port area. The Federal Bureau of Investigation investigates crimes that occur on U.S. vessels or involve U.S. citizens. The U.S. Marshals of the Department of Justice are empowered to detain or seize vessels and crews. All cargo imported into the United States is inspected and cleared for entry by U.S. Customs. The Immigration and Naturalization Service examines crew lists and allows foreign crew members to enter the United States. The U.S. Coast Guard enforces many of the maritime laws of the United States. *(See Chapter 12 for more information.)*

Some state and local governments also maintain specialized maritime law enforcement agencies. The existence and type of marine, environmental, and conservation police or agencies vary within each port and each state. These agencies usually share jurisdiction with their federal counterparts.

5.15 U.S. Army Corps of Engineers. The U.S. Army Corps of Engineers oversees the dredging of all navigable waters of the United States and operates a few dredges located throughout the country. These dredges can be used for emergency dredging to gain access to an area or to free a grounded vessel. The Corps also operates smaller boats that clear flotsam (debris) from channels. These boats can be used to clear floating combustible material from areas threatened by fire.

5.16 Military Installations. Military installations usually are good sources of fire-fighting agents and personnel. Fire stations on these installations usually are well equipped and can often provide compressed air to refill air bottles, foam, pumps, tankers, and fire fighters. In addition, naval bases usually have tugs equipped with fire monitors. Lists of the equipment available at these installations usually are found in the USCG Fire-Fighting Contingency Plan.

5.17 Divers. In most major ports, there are diving companies that specialize in commercial marine work. They inspect and do minor repairs to structures such as vessels, docks, and bridges. They usually are equipped to perform functions such as underwater welding, cleaning, sawing, and drilling. Divers might be needed to make emergency investigations or repairs. In some areas, public agencies provide divers.

5.18 Launch Services. Launch services provide transportation for passengers and equipment from a pier to vessels at anchor or in the channel. They are used to transport crews, federal agents, spare parts, and food to vessels without a berth. Their boats usually are highly maneuverable and relatively fast. They can be used during a vessel fire to provide additional transportation to the burning vessel.

5.19 Ship Chandler. Most vessel operational needs can be purchased through a ship chandler/marine supplier. If the chandler doesn't stock a certain item, he or she knows where it can be purchased. A chandler usually can supply fire-fighting agents and equipment and spare parts for fire-fighting equipment and machinery found on vessels.

5.20 Foreign Consulates and Language Schools. Most vessels entering U.S. ports carry foreign crews that speak many different languages. If the vessel's English-speaking senior officers are injured and translators are needed, foreign consulates and language schools in the area are good sources of translators. A list of translators usually can be found in the USCG Fire-Fighting Contingency Plan.

5.21 Other Organizational Resources. The following is a list of other organizations that can assist or provide resources during a vessel fire:

(1) Federal and state fire agencies
(2) State/county fire marshal
(3) Emergency management agencies/civil defense
(4) Bridge and tunnel authorities
(5) Red Cross/relief organizations
(6) Utility service companies
(7) News media representatives
(8) Self-contained breathing apparatus (SCBA) refilling sources
(9) Hospital supply companies
(10) Fast food restaurants
(11) Welding companies
(12) Oil and hazardous materials cleanup companies
(13) Private fire-fighting services
(14) Aircraft reconnaissance sources
(15) Railroads

Chapter 6 Special Resource Considerations

6.1 Introduction. The unique nature of shipboard fire-fighting points to the need to consider the use of methods and resources beyond those normally employed on the fireground. A good preplan identifies not only target hazards but also special personnel and resources available to provide assistance. Because most responders involved are likely to be unfamiliar with shipboard fire incidents, it is essential to smooth emergency management that realistic drills be held to train responders and assess operations before a real emergency occurs. A pre-fire plan should include a checklist that is specific to the area. Some of the special resources that might be included on the list are described in Sections 6.2 and 6.3.

6.2 Support Vessels. With the exception of dry-dock fires, most ships will be accessible by water. In some cases, water is the only means of access. A vessel at anchor might need to be moved, or a burning vessel might need to be stopped from drifting. Vessels providing towing assistance might be able to provide fire-fighting streams. These can be helpful in extinguishing the fire but could endanger the stability of the vessel that is on fire.

6.2.1 Fireboats. A fireboat is a vessel designed for fire fighting and is staffed by trained fire fighters. For the safety of vessel personnel, vessels should be able to function safely and adequately in their anticipated operating environment. Fireboats are made in many sizes and designs. Design features such as noncombustible construction, spray protection, and an onboard air supply should be considered for the protection of the fire-fighting personnel. Fireboats serve three basic functions.

(a) *Rescue.* Fireboats provide rescue of personnel and transportation of fire crews and equipment from incidents that are inaccessible from shore. A fireboat often is the primary escape route for fire crews.

(b) *Platforms.* Fireboats provide a fire-fighting platform for delivery of agent through monitors or through hoselines from the fireboat to the fire crew on board the vessel. A fireboat can function as a mobile command, as staging, and as a pumping base.

(c) *Water Supply.* Fireboats provide water supply for shoreside operations. Remote pumping can be as simple as hooking up to a dockside manifold or hose lay, or it can involve anchoring in deeper water off a beach and sending supply lines ashore via a boat drag. Some fire departments equip fireboats with large-diameter hose so as to have a secondary water supply in case the underground mains are broken in an earthquake, explosion, or pier collapse or in case of insufficient shoreside capacity.

6.2.2 Auxiliary Vessels. Many commercial vessels can be pressed into service in an emergency, either by preplanned agreement or as vessels of opportunity.

6.2.2.1 Tug Boats. Tug boats come in many sizes and configurations. A list of those that are available and their capabilities should be developed.

6.2.2.2 Barges. Barges can provide large, flat, stable working areas that are mobile. They have the potential to store debris and contaminated product and runoff. They have been used as platforms from which land-based fire engines can draft and pump.

6.2.2.3 Offshore Supply Boats. Offshore supply boats carry heavy equipment and supplies and often have cargo-handling equipment.

6.2.2.4 Pollution Response Vessels. Pollution response vessels carry booms and skimmers for oil containment and cleanup. These vessels and their equipment are rarely fire resistant.

6.2.2.5 Crewboats and Launches. Crewboats and launches can carry personnel and limited supplies.

6.2.3 Military Vessels. Military assistance is available from a number of sources, including regular, reserve, National Guard, and auxiliary units.

6.2.3.1 USCG. USCG vessels have limited fire-fighting capabilities. Many vessels, both small and large, are equipped with monitors/nozzles. They have water rescue equipment and some fire-fighting training. The USCG Captain of the Port has broad powers over all vessels in the area. USCG helicopters can be used for transportation, reconnaissance, and rescue.

6.2.3.2 Navy. The navy also can assist on the sea and in the air. Local commanders and the COTP usually can be found in the USCG Fire-Fighting Contingency Plan.

6.2.3.3 Army Corps of Engineers. The Army Corps of Engineers is responsible for dredging and channel maintenance, and often they can provide assistance.

6.3 Special Equipment Resources. Shipboard fires necessitate special types of equipment and quantities that exceed normal needs.

6.3.1 Pumps and Dewatering Equipment. There are many marine pumps/eductors capable of dewatering vessels. It might be necessary to work pumps in tandem, sending smaller ones into tight quarters and relaying through larger ones on deck. Specialized pumps/eductors and dewatering eductors usually can be found in the USCG Fire-Fighting Contingency Plan.

6.3.2 Patching, Salvage, and Shoring Equipment. Patching, salvage, and shoring equipment is needed to control leaks and seal breaches.

6.3.3 Fire-Fighting Equipment. The fire department should bring its own hose and appliances, as there is no way to guarantee the condition of a ship's equipment or its compatibility with fire department equipment. The fire department should depend on its own water supply for attack operations.

Fog applicators that come in 4 ft, 10 ft, and 12 ft (1.2 m, 3.1 m, and 3.7 m) extensions fit on "navy all-purpose" nozzles. They basically consist of an open sprinkler head at the end of a curved pipe. They allow penetration of small openings such as open portholes. Piercing applicators can be used to penetrate certain materials and shipping containers.

Heat and flame detectors (thermal imagers) are valuable in smoky, confined spaces on ships.

Monitoring equipment for temperatures, gases, oxygen, and hazardous materials might be needed in some situations.

Special communications equipment might be needed for interior use. In some cases, the vessel's communications systems supplement portable radios. On-scene support equipment includes lighting, ventilation, air supply, recording equipment (video/audio), office supplies and copiers, food, shelter, transportation, and sundry supplies, such as fuel and batteries for extended operations.

Special cargo-handling equipment might be necessary for manipulating cargo and bringing supplies aboard. If this equipment is available on the ship or at the dock, such use should be coordinated through the stevedore.

Chapter 7 Planning

7.1 Introduction. Experience has shown that in incidents where shoreside fire fighters fight a vessel fire, one of the most valuable assets on the ship is the fire control plan. Most of the information an incident commander needs to fight a fire on a ship, such as general layout and dimensions, fire-fighting systems, and other systems that have a direct impact on fire fighting, is included in the fire control plan. Its primary purpose is to assist shoreside fire-fighting personnel. It is ideal for fire fighters to use as a guide when taking tours of ships, since it contains the location of most of the items they will be looking for, and it also allows them to become familiar with fire control plans.

7.2 Contents of Plan. The fire control plan is a set of general arrangement plans for each deck of the ship that also contains information that is useful to land-based fire fighters. The plans are written in the official language of the flag state, with translation in English or French. The plans can be in the form of a rolled set of drawings or a booklet that includes such drawings.

The plans are required by SOLAS to indicate the following, when installed:

(1) Fire control stations (continuously staffed spaces where controls and alarm panels for fire detection and suppression systems are located)
(2) Means of access/escape from different compartments
(3) Fire-resistant bulkheads and their fire rating (e.g., Class A and Class B)
(4) Hose stations, which should include the arrangement of the fire-main system, with the locations of fire pumps and their controls and the location of isolation valves in the system
(5) Location and extinguishing agent of portable and semi-portable fire extinguishers
(6) Fixed carbon dioxide and halon systems, locations of releases, and location of closing appliances for exterior ventilation openings
(7) Automatic sprinkler systems and location of controls
(8) Foam system showing the monitors and controls
(9) Fire detection systems showing location of indicator panels and spaces protected
(10) Alarm systems (carbon dioxide, halon, automatic sprinkler, fire detection, watertight doors, general)
(11) Ventilation systems, including dampers and fan controls

In addition, the following items should be marked clearly:

(1) Fire door locations and their rating (e.g, Class A or Class B)
(2) Location of international shore connection

7.3 Location of Plan. Most commercial vessels are required to have fire plans on board. The fire control plan is required to be permanently stowed in a prominently marked weathertight enclosure outside the deckhouse. Some vessels, often tank vessels, will provide a copy of the fire plan and international shore connection at the top of the gangway when in port. This is not required, but it is common practice. Fire plans will provide the diagrams of the fire system, including the fire mains, hydrants, foam systems, and all fire stations. The CO_2 systems and the compartments they protect are part of the plans. Investigations have shown that, in the past, even when shoreside fire fighters were aware that the fire control plan existed, they had trouble finding it. In response to this problem, the International Maritime Organization (IMO) published specific guidance on locating and marking the fire control plan enclosure.

The enclosure should be red and the contents of the enclosure should be indicated by a red ship silhouette on a white background. The dimensions of the location sign should be not less than 11.7 in. × 15.7 in. (297 mm × 400 mm). *[See Figure 7.3(a).]*

If the enclosure is not adjacent to the gangway, there should be guide signs to help shoreside fire-fighting personnel find the enclosure containing the fire control plans. The guide sign should be the location sign shown in Figure 7.3(a), with the addition of a red arrow [*see Figures 7.3(b) and 7.3(c)*] indicating the direction in which the fire control plan enclosure can be found.

7.4 Requirements. Fire control plans are required by both SOLAS, Chapter II-2, Regulation 20, and 46 *CFR*, 78.45-1(a)(1) and 97.36-1(a). Therefore, all new and existing U.S. flag and foreign flag ships entering U.S. ports should carry a fire control plan.

FIGURE 7.3(a) Fire plan location sign.

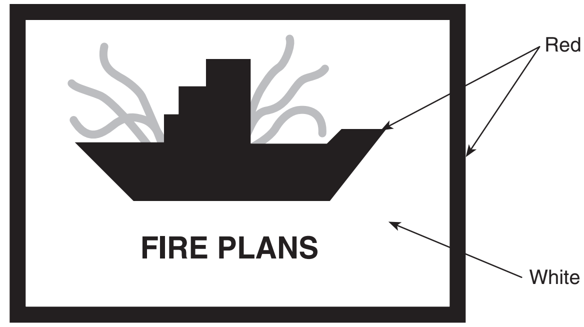


FIGURE 7.3(b) Guide sign.

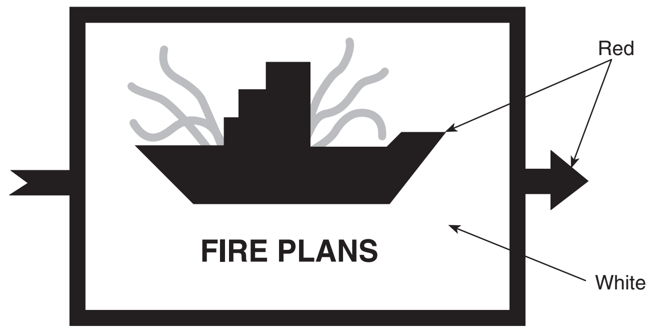
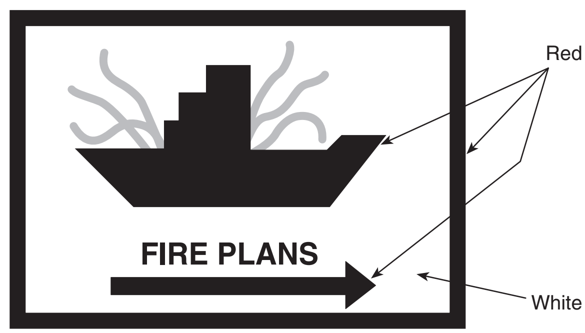


FIGURE 7.3(c) Alternate guide sign.



7.5 Pre-fire Planning. Shipboard fires are among the most difficult of all fires to extinguish. They have the capability to tax the resources of entire regions. Realistic and effective pre-fire planning is crucial to deal successfully with such emergencies. Without pre-fire planning and drills, the wide variety of resources and specialists needed at a shipboard fire can rapidly turn a command post into chaos.

Incident commanders who are unfamiliar with the maritime industry need to know how to acquire and to utilize special help before an incident occurs. Pre-fire planning puts problems into perspective by defining the larger picture at a time when it can be studied at leisure.

General pre-fire plans focus on areas and environments. They set a hierarchy of goals in the mitigation process and provide a general sense of direction. All responders need to understand their roles and responsibilities and the scope of their authority.

A general pre-fire plan considers factors such as human and environmental protection, scope of authority of responders, preferred locations for operations, and major hazards to the port and its inhabitants.

Specific pre-fire plans focus on target hazards and provide a guide to the ship's systems and facilities. They consider characteristics of vessels and terminals and help identify aids and hazards, as well as strategy and tactics. They can be tailored to individual ships or general classes of vessels.

Response plans should be part of standard dispatch procedure and should provide for notification of affected parties.

7.6 Purpose of Pre-fire Plan. In addition to its use during fire operations, a pre-fire plan is useful as a training aid. By using the pre-fire plan during training, fire personnel can remain familiar with the ship's vital systems even though they might not have the opportunity to board the vessel for frequent familiarization tours.

7.7 Format. The pre-fire plan is intended to be made available for the review and use of each first alarm responding unit. In addition, a copy should be provided to the masters of ships that visit the port regularly. The plan can be divided into several major sections, with each section divided into specific areas pertaining to the main topic. Illustrations can be utilized to emphasize an important point or to clarify the text.

7.7.1 Section I, General Information.

7.7.1.1 The first part of this section provides the name of the vessel, general use, name of the owner, operator, or representatives, number of crew members, number of passengers/cadets carried, and any other pertinent information, such as languages spoken by the officers.

7.7.1.2 The second part of this section describes the physical properties of the vessel such as length, breadth, depth, freeboard, overall height above water (empty and loaded), draft, propulsion, fuel used, and fuel capacity.

7.7.1.3 The third part provides telephone numbers to call in case of an emergency (e.g., ship's agent, insurance company). The staffing practices of the vessel also are noted (e.g., how many crew members are aboard during the day and at night).

7.7.2 Section II, Construction.

7.7.2.1 The first part of Section II contains a drawing, not necessarily to scale, showing the general location and names of the decks, holds, compartments, and machinery spaces. This drawing is intended to be a quick and simple guide to the vessel's general arrangement. It can be obtained from the vessel fire control plan.

7.7.2.2 Part two of Section II provides the specific name and location of each deck. The general types of compartments on each deck also are indicated. This part also indicates compartment identification (either by name or number). The frame numbering system is explained as well, and all locations are specified by frame number.

7.7.2.3 The third area covered under Section II includes the cargo hold numbering system, indicates the type of hatches used, outlines the means of access to the cargo holds, and specifies the capacity of each hold. The locations of machinery spaces and other compartments are given, and the means of access are described.

7.7.3 Section III, Location Lists.

7.7.3.1 The normal storage area for specific information is included in the first part of Section III. This information includes the stability plans, cargo manifest, dangerous cargo manifest, ship's blueprints, safety plans, and similar data that is helpful in an emergency.

7.7.3.2 The second part of this section lists all spaces in the ship having escape trunks, such as the shaft alley, holds, and machinery spaces.

7.7.3.3 The locations of the instruments and controls are included under part three of Section III. The operating instructions are not provided here, but are addressed in a later section.

7.7.3.4 The last part of Section III provides the exact location of every compartment on the vessel in alphabetical order. It indicates the frame number, deck location, and whether the compartment is on the port or starboard side of the centerline. In addition, primary access to the space is provided.

7.7.4 Section IV, Systems Information.

7.7.4.1 Communications systems are included in the first part of Section IV. This section describes the vessel's intercommunications systems and provides instructions for the operation of each. The location of all stations within the system is identified and noted.

7.7.4.2 The second part of Section IV discusses the electrical systems within the vessel. The method for generating electricity is stated, as well as the type of current generated and the voltage. The emergency power unit is described, including the system that it powers. Some primary control switches are indicated and their function is explained (e.g., main ventilation switches). The voltage and maximum current-carrying capability of shore power connections, if any, are identified.

7.7.4.3 The vessel's fire-protection systems are summarized in the third part of Section IV, and the area the system protects is indicated. No specific operating information on the systems is provided in this part. Ships may have a variety of detection systems. These systems detect smoke, heat, or cargo leaks. Ships may have one or all of these systems. The ship's crew should be consulted to determine what kind of systems are on board and how they are operated.

7.7.4.3.1 Smoke Detection Systems. Smoke detection systems come in two basic types: remote detectors that are similar to those found in buildings and air sampling units that utilize a single detector at the master station. Detection systems are valuable when monitoring the spread of fire. They can provide early warning if extension of the fire occurs. Caution should be used when utilizing these systems to monitor cargo spaces, since they are often secured to prevent false alarms. The following are some characteristics of smoke detection systems.

(a) Remote detectors are most often found throughout the superstructure on the vessel. They will normally be monitored from a control station on the bridge.

(b) Remote air-monitoring systems utilize a pump to draw samples of air from each compartment sequentially from a series of pipes. The pipes join in a junction box where a single smoke detection unit can be found. The samples are usually vented to the atmosphere outside the bridge. When the detector is activated, some mechanism is used to signal which zone the sample came from.

(c) Remote sampling systems often utilize the same piping system that draws samples to discharge CO_2 into those spaces.

7.7.4.3.2 Heat Detection Systems. Heat detection systems utilize the same principles found in land structures. These systems typically monitor rate of rise, specific temperatures, and a variety of other mechanisms.

7.7.4.3.3 Gas Detection. Certain vessels will have installed gas detection systems on board. The most common are the LP-Gas, LNG, or other gas vessels. These systems are made to detect cargo tanks' leaks. These systems can usually be monitored from the bridge and sometimes from the cargo control room.

This part of Section IV is intended as a quick reference to determine the types of systems available on the vessel (e.g., watertight doors, fire doors, fire walls, CO_2 systems, foam systems).

7.7.4.4 In the fourth part of Section IV, the fire-protection systems are discussed in detail. Directions are given for the operation of each system. For example, the CO_2 system is explained in detail. A drawing of the system is included and instructions are given for the operation of the system. Independent systems also are noted and explained. All instructions are keyed to photographs of the systems controls.

7.7.4.5 The general alarm system is discussed and the areas protected by the system are provided in the fifth part of Section IV.

7.7.4.6 The sixth part of Section IV contains information on the watertight doors. They are explained in detail, and if remote controls can be used, these also are discussed. Controls are explained, and instructions usually are accompanied by an illustration.

7.7.4.7 The ventilation systems are discussed in the seventh part of Section IV. All emergency controls are noted and locations indicated. Natural ventilation to the holds and to some compartments is discussed. Illustrations are used to show key features or controls of the system.

7.7.4.8 The eighth part of Section IV discusses emergency control for the fuel system. Remote emergency control locations are indicated and instructions are given for their operation. If manual controls are used for a backup system, their location is indicated and an explanation is given for their operation.

7.7.5 Section V, Tactics.

7.7.5.1 General information items are discussed in the first part of Section V. The location of the master keys for the various compartments is provided. If no master keys are available, vessel personnel with keys for gaining access to the compartments are indicated. If safety plans or fire plans are posted on the vessel, their location is given. The emergency gear/damage control locker is identified, and hazardous cargo stowage is located (as well as the hazardous cargo manifest).

7.7.5.2 The second part of Section V discusses items to be given special consideration. The international shore connection is identified and its location indicated. Instructions for supplementing the CO_2 system from a shoreside supply are provided. In addition, special safety precautions are recommended.

7.7.5.3 Fire exposures are identified in the third part of Section V. Exposures include flammable liquid tanks, flammable gas tanks, explosives, open stairways, nonprotected laundry chutes, or any substance or material aboard the vessel that would help to spread or accelerate a fire.

7.7.5.4 In the fourth part of Section V, the length of fire hose and its accompanying nozzle at each onboard fire station are noted, as well as the minimum length of hose needed to reach a given area. The locations of appropriate adapters and fire department international shore connections are clearly marked and accessible for shore hookup. The maximum operating pressure of the fire-main system should be identified during pre-fire planning.

7.7.5.5 The last part of Section V is the Action Check-Off List. This list assists personnel in making certain nothing is overlooked. The list provides a check for the following categories of information:

(1) Nature of emergency
(2) Life hazard
(3) Data acquisition, which includes obtaining information that is available aboard the vessel (such as a pre-fire plan, ship plans, dangerous cargo manifest, cargo manifest)
(4) Locating the fire or emergency
(5) Checking the exposures
(6) Access to the fire or emergency
(7) Vessel systems/equipment that can be utilized
(8) Stability/dewatering
(9) Ventilation

7.7.6 Section VI, General Arrangement. Section VI includes plans that have general measurements and show the arrangement of decks, compartments, and holds. Each deck usually is on a separate page. Smaller decks, such as the bridge deck and boat deck, might be grouped together on one page.

7.8 Conducting Pre-fire Surveys. In order to conduct a pre-fire survey properly, the surveyor needs the right equipment. The following items have been found to be helpful:

(1) Clipboard, pencils, note pads
(2) Pre-fire survey guide
(3) Ship arrangement plans
(4) Audio, video, and photographic equipment
(5) Sample pre-fire plan (if available)
(6) Tape measure

The survey should be conducted with the master or the master's designee. The individual conducting the survey should contact the master of the vessel for an introduction and explain the purpose for boarding. Then, utilizing the survey guide, the surveyor should complete as many of the survey items as possible from a review of the vessel's general specifications, or from information obtained from the master, before beginning any tour of the ship. A sample survey guide is found in Appendix B.

7.8.1 Upper Decks. Proceeding downward, the surveyor should tour the upper decks, documenting the following:

(1) Deck arrangement
(2) Compartmentation, vertical fire zones, and ratings
(3) Access to emergency egress to other spaces (machinery)
(4) Special controls for systems
(5) General use of area
(6) Special features
(7) Safety hazards

7.8.2 Engine Room and Machinery Spaces. The surveyor should proceed to the engine room and machinery spaces, noting the following:

(1) Access (regular and emergency)
(2) Type of machinery encountered
(3) Type of fire protection systems
(4) Location of controls
(5) Fire pump controls

(6) Ventilation shutdowns
(7) Emergency shutdown
(8) Watertight doors
(9) Location of flammable liquid tanks
(10) Shaft alley escape trunk
(11) Safety hazards

7.8.3 Cargo Spaces. The cargo spaces then should be surveyed. On some vessels, it might not be possible to enter all the cargo spaces due to hazards or because they are full. However, where possible, they should be entered and the following information recorded:

(1) Access (regular and emergency)
(2) Type of fire protection systems
(3) Deck and hold arrangement
(4) Special use areas (cargo tanks, reefer boxes)
(5) Storage practices (locking off spaces, verifying status of controls for systems)
(6) Safety hazards
(7) Types of hatch covers and their controls

7.8.4 Bow and Stern Areas. The bow and stern areas of the ship then should be surveyed. Since these are areas where machinery and combustible storage often are found, the surveyor should note the following:

(1) Access to spaces
(2) Types of fire protection systems
(3) Hazardous storage
(4) Machinery in use
(5) Flammable liquid tanks
(6) Housekeeping
(7) Safety hazards

7.8.5 Weather Decks. The survey should conclude on the weather decks, including the forecastle, the poop deck or fantail, and the main deck. Items to be checked are as follows:

(1) Access to holds and other interior areas of the vessel
(2) Deckhouses and their contents
(3) Winch controls (operating procedures should be determined)
(4) Hazardous cargo storage
(5) Connections to the fire main
(6) Deck fitting, piping, and obstructions
(7) Types of fire protection systems
(8) Safety hazards
(9) Fire control plan location
(10) International shore connection

7.8.6 Photographs. Photographs are an essential component of the pre-fire survey. They should be taken, if allowed. Much of the data contained in the survey is of a technical nature and can be clarified if appropriate photographs or drawings with superimposed identification are used. In general, anything that would increase understanding of the survey should be photographed. This might include photographs of the following:

(1) Systems controls
(2) Systems components
(3) Instruments
(4) Arrangement features
(5) General ship views

Chapter 8 Training

8.1 Introduction. Once the pre-fire plan has been completed, a fire department can establish drills and training sessions on board the vessel. The pre-fire plan indicates the location and identity of important aspects of the vessel that shoreside fire fighters need to know in an emergency situation.

Tours and drills should be scheduled through the appropriate authorities to minimize interference with the vessel and terminal operations. The appropriate size for a touring group should be determined prior to boarding the vessel. Generally, it is difficult to tour a vessel effectively with large groups. For this reason, several tours might need to be scheduled in order to familiarize as many personnel as possible.

8.2 Training Exercises. The function of a training exercise is to ensure that the plans and procedures can be implemented.

Because most land-based fire fighters fight shipboard fires infrequently, the value of a marine fire-fighting exercise is immeasurable. The exercises that have been conducted by fire departments throughout the United States have proved to be of significant benefit when response to a shipboard fire is necessary.

Arrangements should be made with the terminal management and the ship's owner/operator for the purpose of conducting a full dress rehearsal of an incident. This includes search and rescue, deployment of water curtains, master streams, and attack lines, and deployment of fire department ladders for boarding a ship at locations other than the gangway.

Before an operation of this size can be conducted, extensive planning is necessary. The COTP and ship's master should be involved with all fire company officers who are to be a party to the operations. Mutual aid personnel should be included. On-site visits and discussions to familiarize the participants with the intended operation should be conducted.

Coordination for drills and exercises is essential. Agencies involved in the drills might be unable to suspend work during the exercise.

The ship and terminal personnel cannot stop work during on-site visits. There are days or nights when work is not in progress. This is particularly true at liquid bulk transfer facilities. Often, especially on a Sunday or while waiting for a favorable tide, a ship is berthed and is not transferring product. This is the time to conduct a drill.

Often a local towboat and tank-barge company provides the towboat and barge with their crews for a full-scale drill. Close cooperation among the COTP, towboat company, and marine terminal is important.

If the drill evolutions are properly planned and conducted, the fire chief will have the support and cooperation of the port community.

It cannot be overemphasized that the fire chief is to include the COTP in all planning and field evolutions. The COTP has broad powers and is held in high esteem in the port community. Cooperation can almost be guaranteed if the COTP supports the training exercise.

In order to conduct an exercise, a plan of operation is needed. A plan is legitimate only when it has been realistically tested. Some of the characteristics of a functional plan are specified in 8.2.1 through 8.2.11.

8.2.1 Coordination. Any plan should be written and reviewed with the input of the participating agencies. Only with this cooperative effort can a training exercise using this plan be truly beneficial. The coordination for a full-scale shipboard fire-fighting drill can take weeks or months after a draft of the plan is written.

8.2.2 Validation. A plan is to be tested by real or simulated situations that assist the planner in determining the functional validity of the plan. Shipboard fire-fighting training exercises should consist of multiple, small, previously validated elements that are then coordinated to form a large-scale drill.

8.2.3 Updating. The plan should be reviewed at least annually or as changes occur. Training exercises should be conducted on a routine basis and especially after major alterations in the plan.

8.2.4 Authoritative Recognition. Before a plan is finalized, it should be submitted to individuals or agencies with recognized experience in tasks included in the plan. These authorities should observe large-scale training exercises and provide independent comment or critical analyses of the drill, plan, and training exercise.

8.2.5 Qualitative Analysis. The quality of the plan is a function of its ability to accomplish the mission for which it was designed and the perception of all users with respect to its "user friendliness." A plan that is difficult to understand and to implement will not be used and, therefore, has no value. If the training exercise does not accomplish the tasks for which it was designed, the plan should be reevaluated.

8.2.6 Critique. After every exercise of the plan or a drill that incorporates the plan, formal and informal critiques should be held. It is neither sufficient nor beneficial to test or critique the plan in small sections and assume that a large-scale exercise works if all components have not been tested simultaneously. The plan should be exercised in its entirety, and the critique should include all facets of the exercise and plan.

8.2.7 Incorporation. After each exercise, drill, or test of the plan, the lessons learned should be incorporated into the revised plan.

8.2.8 Debriefing. After each actual emergency, a debriefing should occur at which accurate notes are taken. The lessons learned then should be incorporated into the plan. Debriefings should include discussions of the following areas.

(a) *Tactical.* Actual strategic, tactical, and task accomplishments should be compared to the goals set forth in the plan, and inconsistencies between the plan and tactical objectives should be the primary focus of tactical debriefings. All participants, from the chief to the driver, should be debriefed.

(b) *Critical Incident Stress (CIS).* The focus of critical incident stress debriefings is the mitigation of the effects of an incident and its by-products on the participants. It is useful to revise the plan in an attempt to reduce stress on the fire/rescue personnel, if possible.

8.2.9 Video Review. It is extremely useful to have these records for review and analysis.

8.2.10 Audio Review. It is extremely useful to have these records for review and analysis.

8.2.11 Log Review. It is essential to have these records to document changes in the plan.

8.3 Advanced Fire Fighting — Marine Training. Training of land-based fire fighters in the unique aspects of combating vessel fires should include the following:

(1) Vessel types
(2) Vessel construction pertaining to fire fighting
(3) Stability and dewatering
(4) Strategy
(5) Command
(6) Suppression and ventilation
(7) Available resources for assistance

There are several established schools that provide training in vessel fire fighting for ship crews.

Every port community should develop a comprehensive program and implement a system of support for marine fire training. This program also could provide for specialized equipment for marine fire fighting.

Each jurisdiction should have the ability, knowledge, and resources to utilize and to obtain this specialized training within its region.

Some of the resources that should be utilized to develop this program include fire chiefs' associations, port authorities, the USCG, federal, provincial, and state governments, the insurance industry, and maritime academies and associations.

Local training programs can include tabletop exercises, review of past ship fires, and simulation exercises. Training exercises should address water supply problems, particularly drafting, access ladder use, air supply problems, and personnel rescue problems.

The types of simulations that can be exercised for marine fire fighters are as follows:

(1) Engine room	Fuel line break and fire Electrical fire Victim extrication, lower level
(2) Pump room	Broken pump seals and fire Electric pump motor fire Victim extrication, lower level
(3) Dry cargo areas	Tank top fire or rupture, or both Bottom hold cargo fire, access to tween deck cargo fire, and access to upper deck or shelter deck fire
(4) Tank ship hold	Interior tank fire Weather deck fire Product pipe system on deck Rupture or fire, or both Product cascade hose Connection and valve rupture or fire, or both
(5) Accommodation spaces	Personnel berthing quarters fire Galley fire Laundry room fire Mess room fire Electrical fire Cooking gas fire Ventilation system fire Multiple victim extrication from various spaces

8.4 Personnel Safety. Numerous hazards to personnel exist on the waterfront.

8.4.1 Marine fire fighting requires the use of full protective clothing and equipment as required for structural fire fighting in Chapter 5 of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program.* The additional use of personal flotation devices is encouraged, but not at the expense of wearing full protective clothing and SCBA. Personal flotation devices (pfds) should be provided to all personnel who respond to marine incidents.

In the winter, fire fighters in boats should be wearing protective flotation suits rather than turnout gear. These suits will prevent hypothermia should personnel fall into the water. It must be decided early in the incident whether personnel should be utilizing turnout gear when boarding a vessel. This decision is especially important when vessels are under way or at anchor. It may be more practical and safer for personnel responding to vessels at anchor to carry turnout gear and don it on scene.

Special consideration should be given to maintaining adequate air supplies. The 30-minute SCBA for standard fire fighting has frequently proven insufficient in vessel fire fighting.

8.4.2 Marine fire fighting presents the hazard of personnel falling into the water. Provision should be made for locating and rescuing such victims immediately.

It is crucial that the incident commander have a rescue boat on scene should personnel fall into the water. Piers are often high above the water and may prevent rescue from shore. Fireboats generally are too large and their freeboard too great to allow them to rescue people in the water. Small rescue craft are crucial to fire fighters' safety. The IC should ensure that rescue boats are dispatched early, since it usually takes them additional time to arrive on scene.

In some areas, hypothermia is a concern; therefore, minimization of the time spent in the water awaiting rescue is critical.

8.4.3 Provisions should be made for adequate access and egress for emergency personnel by means of additional gangways, ladders, or other devices. Where conditions allow, provisions should be made for the possibility of water rescue.

Floating piers often have weight limits that are rapidly exceeded if several fire fighters in turnout gear and SCBA congregate on them. Fire fighters should be trained to recognize these hazards before they end up in the water.

The use of a Jacob's ladder for boarding vessels can be hazardous. Alternate means should be used if possible. Prior familiarization with the use of these ladders is essential.

It is recommended that an evacuation procedure and signal be established in case of the need to abandon ship. Care should be taken to ensure the safe and systematic withdrawal of all personnel.

8.4.4 Vessels have large, deep, undivided spaces and areas, such as cargo holds and engine rooms, with many fixed obstructions, such as machinery. Fire personnel should move about the vessel with extreme caution.

Prior to entering vessel spaces, fire personnel should review diagrams for the specific area and consult with the vessel's crew.

Hot steel surfaces and structural members can be harmful to personnel and equipment.

Ice or snow is a hazard on the decks of pier facilities and on board ships.

Ship ladders can be very steep with narrow steps. Personnel should face the ladder at all times.

8.4.5 A ship has its own utilities. Lighting and power systems usually are completely independent from any shore connection. There is little if any light available below deck when the main or emergency electrical system is not functioning. Fire departments should provide portable lighting systems with generators. If the incident could involve flammable vapors, the portable electrical equipment should be intrinsically safe. Portable battery units also should be suitable for use in hazardous locations (i.e., intrinsically safe).

Chapter 9 Communications

9.1 Introduction. In any fire suppression, rescue, or hazardous material operation, effective, disciplined, and established communications procedures are necessary for safe mitigation of the incident. These procedures are even more stringent for a shipboard fire, since the uniqueness of the environment (ship construction and size and the possible involvement of numerous personnel and various agencies) necessitates that the incident commander be provided with adequate and reliable communications systems and procedures.

The structure of most large vessels creates communications difficulties for responders. Large amounts of steel often make portable radios unusable. The long duration of these incidents often depletes reserves of batteries. Alternate means of communications (i.e., runners, sound-powered phones, wired systems, and even the ship's systems) should be considered in pre-fire planning.

It should not be presumed that because a fire department's radio procedures and systems meet its routine needs that they automatically meet its needs during a shipboard fire. However, as with any major incident/disaster, a department's operations should be an extension, by degree, of its day-to-day operations.

This chapter identifies various communications considerations, practices, procedures, and systems. Where applied in conjunction with Chapter 7 and Chapter 11, this information assists personnel involved in combating a fire aboard ship to establish effective communications.

9.2 Pre-fire Planning. Pre-fire planning for shipboard fireground communications is a significant issue because of the many unique aspects of a shipboard fire.

The following questions regarding shipboard fireground communications should be given careful consideration when pre-fire planning for a fire aboard ship:

(1) Has the possibility of fire-fighting units from various departments/agencies operating at the same incident been taken into account?
(2) Is there a common radio frequency(ies) on which to communicate?
(3) Are there established and recognized radio procedures and call signs that can be utilized by all agencies involved?
(4) Which existing shipboard communications systems can be utilized by fire suppression personnel to supplement radio communications?
(5) Have drills been conducted to identify the effectiveness/limitation of all types of communications systems that can be utilized?

9.3 National Mutual Aid Frequencies. One source of frequencies that should be given careful consideration is reserved by the Federal Communications Commission (FCC) for use by the fire service for mutual aid purposes. Such use is to be primarily for base-mobile operations. These frequencies are licensed as intersystem radio frequencies and are 154.265, 154.280, and 154.295 MHz in the VHF spectrum.

The FCC also has authorized five 800-MHz frequencies for use in mutual aid operations as follows:

(1) I-CALL 821.0125 (mobile input) 866.0125 (mobile out)
(2) I-TAC 1 821.5125 (mobile input) 866.5125 (mobile out)
(3) I-TAC 2 822.0125 (mobile input) 867.0125 (mobile out)
(4) I-TAC 3 822.5125 (mobile input) 867.5125 (mobile out)
(5) I-TAC 4 823.0125 (mobile input) 868.0125 (mobile out)

9.4 Terminology. It is important that the radio terminology used is similar to terminology that is used on a daily basis. Fire fighters should be familiar with the nautical terminology used on board ships so they can communicate effectively with marine personnel. Effective fireground radio communications should include the following:

(1) Identify who is calling whom.
(2) Obtain acknowledgment before continuing, keeping messages short and to the point.
(3) Use ship terms only when they enhance clarity.

9.5 Procedures. The pre-fire planning process should include adoption of procedures that, when employed, serve to manage radio traffic effectively. Those who need to communicate via radio should do so in a manner that does not have an overall negative effect on the operation. The procedures should include the following:

(1) Development of a radio resource list that includes an inventory of how many portable radios are available at a given incident
(2) A listing of the frequencies, channels (simplex, low output, tactical, FMARS), and scanning capability with which the radios are equipped

This inventory allows for consideration of how the available radios, given their operational features, can be best utilized. Reallocation of radios might be desirable in order to make the proper equipment available to those who most need it.

An example is a unit (company) leader assigned to a suppression operation; he/she might need tactical channel capability but might not need scanning capability. Conversely, sector commanders might need scanning capability but not a tactical channel. The incident commander might need to communicate with sector commanders, as well as with other involved agencies. If such factors are considered in advance, it will greatly facilitate efficient fireground operations.

9.6 Fixed Communications Systems for Ships. All large ships are equipped with internal telephone systems. These systems can be very effective. The ship's master can identify the type of onboard telephone system and how it can be utilized during a fire.

Most larger ships also utilize low output portable radios to allow the ship's crew to communicate with key personnel. These radios can be an important asset.

Marine radio frequencies are an ideal means by which to communicate from ship to ship during a marine fire-fighting operation. A typical use of these frequencies would be for an incident commander to give direction to or receive reports from tugboats, pilot boats, or Coast Guard boats. The use of these frequencies should be coordinated with the COTP.

9.7 Communications Logistics. The three principal communications logistical needs that should be considered are extra portable radio batteries, battery rechargers, and additional portable radios.

9.7.1 Portable Radio Batteries and Battery Recharging. Given the long duration that can be expected in a shipboard fire incident and the considerable radio traffic that occurs, portable radio batteries need provision for replacement and recharging. Pre-fire planning should include the availability of extra batteries and a means to recharge batteries on the scene.

9.7.2 Additional Portable Radios. The need for portable radios by other involved agencies (e.g., the Coast Guard, tugboats) might necessitate loaning such agencies a fire department portable radio to achieve effective communications. Considering the large size of many ships, there could be a deployment of personnel that is larger than expected and who are totally dependent on portable radio communications. This increased deployment could exceed the number of portable radios available. Plans should include the acquisition of extra portable radios from elsewhere in a department's organization (e.g., fire prevention, training, personnel, administration).

9.8 Communications Inhibitors. The very nature of a ship's construction, which is mostly steel, creates an immediate negative impact on good, clear communications. During ship's tours, radio tests between portable radios and mobile radios should be conducted to identify any limitations.

Whenever operating on the decks or in the holds that are below the waterline, communications to or from a ship will most likely be impossible to achieve. Radio communications below deck might be improved if transmissions are made near portholes or if radios are used "in relay" to transfer messages.

9.9 Miscellaneous Considerations. During the changing environment of a major shipboard fire, one of the simplest steps that can be taken to minimize radio communications traffic is to use means other than radio whenever possible. For example, a person can be assigned to deliver messages.

Mobile communications units should be assigned where available. Cellular telephones, both mobile and portable, can be utilized as part of an effective communications plan.

Computers can be used to store a complete pre-plan, including all aspects of communications capability and availability data. They can be used in conjunction with CHEMTREC and other HAZMAT data bases.

Because portable radios are susceptible to humidity and water damage, provisions should be made to dry, replace, and repair radios at the scene.

Chapter 10 Strategy and Tactics

10.1 Introduction. Vessel fire-fighting strategy necessitates that the incident commander choose between an offensive and a defensive strategy. The danger to fire-fighting personnel and exposures needs to be weighed against the dangers to the vessel and cargo.

10.2 Offensive Strategy. Where resources are adequate and the vessel's environment is tenable, an offensive strategy might be appropriate. The incident commander can choose from a number of strategies, ranging from an aggressive handline attack to remote agent application or smothering.

Strategy is goal oriented. The incident commander should develop a list of desired outcomes. Tactics should be continually evaluated against the desired outcomes. The ability to achieve tactical objectives serves as a guide to the feasibility of the strategic goals.

10.3 Defensive Strategy. Where resources are insufficient for extinguishment or where the danger to personnel, environment, or exposures outweighs other considerations, a defensive strategy might be appropriate. The incident commander's options are containment and exposure protection or removal of the vessel to an appropriate location.

10.4 General Tactics. There are many different types of fires that can occur aboard vessels. As with any fire incident, initial fire department actions should address rescue of endangered persons, protection of exposures, confinement, and prevention of fire spread. Other tactics and strategies, and their order of precedence, vary depending on the type of fire situation and location on the vessel.

10.4.1 Ventilation. As is the case in some structure fires, incorrectly ventilating a vessel space can cause a backdraft explosion. Any use of ventilation as mentioned in Sections 10.5 through 10.16 and throughout this document should be carefully considered before its application as a strategy. Usually it is essential that ventilation not be established until a coordinated attack can be made.

10.4.2 Watertight Doors. Watertight doors can be found throughout a large ship. The operation of the doors should be noted during the pre-fire planning process, as they are vital to the containment of fire, smoke, and water. Due to their very purpose, watertight doors are subject to pressure from water or hot gases. Watertight doors should be opened with extreme caution.

10.4.2.1 Nonquick-Acting Watertight Doors. Nonquick-acting watertight doors are manual and are held in place by slip hinges and, usually, six locking dogs. Because the door could have pressure behind it, it is advisable to open the dogs on the hinged side of the door first. The slip hinges allow the pressure to be released without the door being uncontrollably blown open. The unhinged side can be unlocked when it is safe to do so.

10.4.2.2 Quick-Acting Watertight Doors. Quick-acting watertight doors are manual and are locked with the rotation of a single lever or wheel. The lever or wheel passes through two stages as it is rotated. The first stage partially opens the door to release pressure while keeping the door secured to the door jambs. It cannot blow open in this stage. After the pressure has dissipated, the lever or wheel should be rotated further to open the door.

10.4.2.3 Power-Driven Watertight Doors. Power-driven watertight doors are doors that are operated by means of electric motors. Each door usually can be operated by an electric switch or a hand crank. Operating stations usually are both nearby and remote from the door. Remote electric control stations might be provided with an automatic closing mode that automatically recloses the door on release of the local switch.

10.5 Forward Compartments. The compartments in the bow contain machinery, storage, flammable and combustible liquids, and seawater ballast tanks.

10.5.1 Rescue of personnel in these compartments is very difficult due to the vertical access and vertical ladders that service each deck. It might be necessary to establish a "manhole"/confined space rescue operation on each deck above the victim.

10.5.2 Electrical power to these compartments can be disconnected within the compartments or from the motor control center (MCC) in the electrical room or machinery space. Control of the electrical distribution system should be accomplished by the ship's crew.

10.5.3 Some ships are provided with fixed extinguishing systems for these compartments. It should be determined if the fire department can support or supplement the fixed systems.

10.5.4 Fire fighting in these compartments could be limited to smothering the fire by sealing off the compartment or applying water through cellar or revolving nozzles.

10.6 Aft Compartments. The aft compartments are located in the stern of the vessel. Each level or deck presents problems of access. In some cases, there is only one point of access to these compartments. The decks below the main deck compartments might have two points of access. These compartments generally are larger than the forward compartments.

The compartments contain machinery, storage, combustible liquids, and seawater ballast tanks. The aft compartments are essential to the operation of the ship because they contain the steering system for the vessel.

10.6.1 Rescue on levels below the main deck can sometimes be accomplished by the use of companionways and ladders. Access to the lowest levels can necessitate a vertical descent.

10.6.2 Electrical power to these compartments can be disconnected within the compartments or from the MCC in the electrical room or machinery space. Control of the electrical distribution system should be accomplished by the ship's crew.

10.6.3 Because there might be two points of access to the upper decks, it might be possible to make a direct attack on fire in these compartments. Ventilation also might be possible. Where a direct attack is not possible, the use of cellar or distributor nozzles or the sealing of the compartments might be necessary.

10.7 Pump Room Fires. Pump room fires usually are the result of a mechanical failure (e.g., ruptured pipe, pump failure, ruptured stuffing tube seals).

The following steps should be considered when extinguishing a pump room fire.

(a) The source of fuel to the pump room should be shut off.

(b) Portable extinguishers, $1^1/_2$ in. (38 mm) hoselines, and foam should be used.

(c) The ship's fixed fire-fighting system for the pump room should be activated.

CAUTION

The fire fighter should know how to activate the system or should seek assistance from the ship's engineering officer.

(d) Extinguishing a pump room fire by smothering (securing all ventilation and closing the pump room doors) necessitates the use of extreme precautions. Smothering might extinguish the fire, but the possibility of a reflash or explosion is a real danger. It can take several hours or days for the pump room to cool down sufficiently to prevent a reflash when the room is opened.

(e) In many instances, a ship's crew automatically activates the ship's pump room fire protection system when there is a pump room fire. The fire might be extinguished or contained when the shoreside fire fighters arrive. Fire fighters should take appropriate precautions, such as those specified in 10.7(a) through (d), when approaching a pump room fire under these conditions.

10.8 Tanker Deck Fires. Deck fires are a common type of incident aboard tank vessels. They generally result from the spillage of product on deck from a leaking or burst pipe. Often the spill is contained on deck due to the common practice of plugging the scuppers. This results in product pooling in low areas until there is enough to flow overboard.

10.8.1 The first consideration in dealing with these fires is to shut off the flow of product feeding the fire. This can necessitate stopping the ship's cargo pumps or having the shoreside terminal cease loading operations. Care should be taken not to close valves arbitrarily without a thorough understanding of the effects of such actions, as this can produce a water hammer effect with even worse consequences. Product flowing into navigable waters causes environmental pollution as well as spread of the fire. Oil booms or absorbent pads generally are not fire resistive.

10.8.2 Most spill fires contained on deck can be treated as a static flammable liquid spill fire. They should be extinguished with foam or dry chemical.

As part of the initial size-up, the incident commander should evaluate the vessel's fixed systems. Many tankers have deck foam monitors, which can be pre-aimed or remotely controlled. If the crew has previously activated them, it might not be possible to replenish the system during the incident. The incident commander needs to evaluate the on-scene resources and foam supply in relation to the size of the incident.

10.8.3 If fire spreads into waters alongside the vessel, escape and supply routes could be cut off. The fire could burn the mooring lines, causing the vessel to drift, possibly with fire crews still aboard. The use of hose streams to sweep away or emulsify product on the surface should be considered.

10.9 Tank Fires. During the size-up of a tank fire, the incident commander should consider several factors that are critical to a successful operation.

(a) The status of the tanks involved should be determined. The type of product in the tank and its burning time are important. The level of the tank at the time of ignition and its accessibility should be determined. Obstructions are an influence on the type of attack.

(b) The status of the ship's fire protection systems and its foam system should be determined. The foam system might or might not serve the area involved in fire. The ship's crew might have charged the foam system prior to the arrival of the fire department. If so, it is necessary to verify how much foam concentrate remains. The ship's plan might indicate whether or not the ship's foam concentrate supply can be augmented from shoreside supplies. Lastly, the ship's crew can be very helpful in operating the system.

(c) The operational condition of the ship's fire-main system should be considered.

10.9.1 Fire Attack with Foam. Where foam is used as an extinguishing agent, it is imperative to postpone the application of the foam until sufficient quantities are available to effect complete extinguishment.

The required rate of application needs to be calculated. NFPA 11, *Standard for Low-Expansion Foam*, should be used to determine the application rate. The shipboard fixed system may be permitted to be included in the calculations, provided the system is reliable and charged. Pumping capacity calculations should include foam flow needs plus flow necessary to operate cooling streams. Cooling streams include lines used to protect personnel and to cool exposures and hot surfaces. The following should be considered during foam application:

(1) If possible, the ship should be turned so that foam can be applied from the upwind direction.
(2) Hoseline access to tank fires can be gained through ullage holes, vent lines, ruptures, and manholes.
(3) The ignition of adjacent tanks should be prevented.
(4) During the attack, the following should be observed:
    a. Water from cooling lines should be kept away from foam.
    b. The attack should begin only after sufficient resources are in place to sustain the attack.
(5) When the fire has been extinguished, the following should be accomplished:
    a. The heated surface should be cooled without disturbing the foam blanket.
    b. The foam blanket should be maintained until ignition sources are removed.
    c. The tanks should be inerted, if possible. Carbon dioxide can produce static electricity; therefore, it should not be used.

10.9.2 Fire Attack with Water. If water is the only available extinguishing agent, the following should be considered:

(1) All areas involved are to be accessible to water fog streams.
(2) Water vapor suppression is possible only when water is applied continuously. Personnel should be kept away from the extinguished area because reflash or rekindle is a distinct possibility.
(3) Larger volumes of water are needed; as a result, larger dewatering capability might be needed.

10.10 Engine Room Fires. The main engine room provides propulsion power, electrical power, and steam to the entire ship. Since this is the power center of the ship, an engine room fire renders all but emergency systems ineffective. Emergency systems might not operate due to fire damage or disrepair, or due to their being set in manual mode.

Some engine spaces are separated by watertight bulkheads. If proper closures are made, systems located in the noninvolved spaces might remain operational.

Ships generally are provided with emergency power to supply critical systems, such as emergency lighting.

A main engine room fire usually is an oil fire, either at a flange or in the bilge, or it could be an electrical fire.

An electrical fire in the main engine room should be handled as an electrical room fire.

The following is a list of some of the equipment that is found in an engine room:

(1) Propulsion boilers
(2) Auxiliary boilers
(3) Steam turbines
(4) Diesel engines
(5) Pumps, generators
(6) Electric motors
(7) Hydraulic motors
(8) Electrical distribution centers
(9) Electronic control consoles
(10) Pressure vessels
(11) Evaporators
(12) Heat exchangers
(13) Sewage treatment plants

10.10.1 Personnel Rescue. Due to varied arrangements and the equipment found in main engine room spaces, search and rescue operations are extremely difficult and hazardous.

Assistance from the ship's crew might be necessary to safely overcome hazards such as high-pressure steam leaks, electrical shock, rotating equipment, and difficult access.

10.10.2 Confinement. To prevent the spread of fire and smoke to other areas of the ship, all closures and ventilation to the affected area should be shut off initially. The effectiveness of closure procedures should be verified and any open or damaged dampers identified.

Making proper closures also is necessary to prevent the flow of water from one compartment to another, thus affecting the stability of the ship.

10.10.2.1 All main engine room systems should be shut down from their remote emergency shutdown stations. This usually does not include the emergency lighting, as it is powered from a different area of the ship.

10.10.2.2 The six fire boundaries (fore, aft, port, starboard, above, and below) should be established and cooled.

10.10.2.3 The dewatering needs and availability of the necessary equipment to accomplish immediate dewatering procedures should be determined.

10.10.3* Attack.

10.10.3.1 The secondary fire boundaries for staging of personnel and equipment should be identified and established.

The status of the ship's fixed systems (CO_2, halon, foam) should be identified and evaluated.

If the ship's fixed systems are available and operational, they should be used as soon as evacuation and closure of the space is completed. Entry into a space where fixed CO_2 or halon has been released should be delayed to allow the agent to perform its function.

10.10.3.2 Entry into the engine room should be made through an access at the lowest point possible while wearing full protective equipment.

Before entry is made, it should be determined that adequate fire-fighting equipment, personnel, and agents are available not only to extinguish the fire but to protect the fire fighters. This precaution becomes especially important where considering tight spaces and a possibly complex escape route.

10.10.3.3 Fire-fighting equipment that might be available aboard the ship and might be of assistance to the fire fighter includes the following:

(1) CO_2, halon, foam, and dry chemical portable extinguishers
(2) CO_2 and dry chemical hose reel extinguishers
(3) Foam applicators
(4) Fog applicators
(5) Piercing applicators
(6) Fire hose
(7) Nozzles

10.10.3.4 The preferred agent for fighting a main engine room fire is foam. The amount of foam necessary and the amount available need to be determined. In addition, the compatibility of the available foam and foam-generating equipment need to be verified.

10.10.3.5 Before making entries through power-actuated watertight doors, it should be determined that they are in the manual mode and cannot automatically close on release of the actuating device.

Entry into all machinery spaces should be made with extreme caution, as deck plates and gratings are routinely removed for equipment maintenance, creating trip and fall hazards.

10.10.3.6 Where entry into the involved space can be made at or below the fire deck, ventilation can be established through the uptakes or natural vents to the outside atmosphere. This reduces heat and improves visibility, but care should be taken, as this also introduces fresh air to the fire.

Where entry into the involved space has to be made from above the fire deck, ventilation is to remain secured until extinguishment and cooling are complete. Ventilating before extinguishment pulls the flames up to the fire fighters as they attempt to descend into the space.

10.10.3.7 Areas of an engine room where fire is most likely to occur are the bilge, diesel engine, boiler front, boiler casing, fuel strainer, centrifuge, and stack areas.

A fire in the stack area of a ship can be further complicated by soot deposits. If soot is aerated, it could ignite quickly. When mixed with water, it forms sulfuric acid.

10.10.4 Overhaul/Salvage. When fire is declared extinguished, a "reflash watch" should be established until all cooling and overhaul functions are complete.

A blanket of foam should be maintained in the bilge until it is cooled and pumped out.

Oil leaks should be repaired and oily surfaces cleaned to eliminate the fire hazard.

Throughout the fire-fighting and overhaul/salvage operations, water conservation procedures and dewatering operations should be maintained.

10.11 Electrical Room Fires. Electrical power is generated aboard the ship and is supplied throughout the ship by wires running through cableways/wireways. Starting at the main generator board, these cableways interconnect electrical distribution centers that supply electrical power to the equipment in that sector.

The following are areas in which electrical fires can occur:

(1) Winch control centers
(2) Motor controllers
(3) Motors
(4) Generator boards
(5) Generators
(6) Distribution boards
(7) Galley equipment
(8) Lighting panels
(9) Pump control centers
(10) Computers
(11) Automation control centers
(12) Wireways
(13) Transformers
(14) Propulsion motors
(15) Propulsion control consoles

A ship in port might be hooked up to shore power. The ship might not be generating its own electrical power. The source of electrical power should be verified with the ship's crew.

10.11.1 Personnel Rescue. Due to the varied arrangements and the equipment found aboard ships, search and rescue operations are extremely difficult and hazardous.

Assistance from the ship's crew might be necessary to safely overcome hazards, such as electrical shock, rotating equipment, and difficult access. Special rigging also might be necessary to effect the safe removal of a casualty.

10.11.2 Confinement. To prevent the spread of fire and smoke to other areas of the ship, all closures and ventilation to the affected area should be shut off initially. The effectiveness of closure procedures should be verified and any open or damaged dampers identified.

Power to the involved equipment should be disconnected to reduce the intensity of the fire and possible shock hazard. The ship's crew should be consulted as to location and method of deenergizing circuits, as there might be alternate power supplies and live wires that traverse the space.

All six primary fire boundaries (fore, aft, port, starboard, above, and below) should be identified, established, and cooled as necessary. If cooling of the bulkheads is necessary, dewatering procedures should be established.

10.11.3 Attack.

10.11.3.1 The secondary fire boundaries for staging of personnel and equipment should be identified and established.

The status of the ship's fixed systems (CO_2, halon) should be identified and evaluated. Propulsion motors might have fixed systems that discharge into the motor housing.

If there is an operational fixed system for the space involved, it should be used as soon as evacuation and closure have been completed. Entry into a space where fixed CO_2 or halon has been released should be delayed to allow the agent to perform its function.

10.11.3.2 Entry into the involved space should be made while wearing full protective clothing.

Transformers aboard the ship can contain oil. If the integrity of the transformer is breached, the fire can become a combination electrical and oil fire. The transformer oil could contain a carcinogen and release highly toxic fumes.

Before entry is made, it should be determined that adequate fire-fighting equipment, personnel, and agents are available not only to extinguish the fire but to protect the fire fighters. This precaution becomes especially important where considering tight spaces and a possibly complex escape route.

10.11.3.3 Fire-fighting equipment that might be available aboard the ship and might be of assistance to the fire fighter includes the following:

(1) CO_2, halon, and dry chemical hose reel extinguishers
(2) CO_2 and dry chemical semiportable extinguishers
(3) Fire hoses
(4) Nozzles

10.11.3.4 When fire fighters are ready to make entry into the involved space, ventilation should be established to the outside atmosphere to reduce heat and improve visibility. Smoke ejectors or box fans might be needed.

10.11.4 Overhaul/Salvage. When a fire is declared extinguished, a "reflash watch" should be established until all cooling and overhaul functions are completed.

Appropriate action should be taken to prevent further damage to adjacent electrical equipment.

Special care should be taken where dealing with wireways. They can be difficult to access, and they can spread fire easily from one compartment to another.

10.12 Chemical Tanker Fires. Chemical tankers are vessels that carry flammable and toxic chemicals in tanks on and below decks. They usually carry a variety of different chemicals. Multiproduct tankers are commonly referred to as *drugstores*.

Even if the tanks are segregated by cofferdams, tanks can leak during an incident and result in the mixing of the chemicals, creating an unknown reaction or hazard. By identifying the chemicals that are on board, a proper strategy can be executed. The chemicals can be violently or mildly reactive with water.

While attacking a fire on a chemical tanker, the following should be considered:

(1) The cargo transfer operations should be stopped and pumps should be shut off.
(2) If needed, some cargo can be heated or cooled in the tank by onboard heating or refrigeration systems.
(3) Due to the possibility of electrical shock and the presence of explosive vapors, the power to the area should be secured, and it should be ensured that there is no source of ignition within or added to the area (e.g., static discharge from CO_2 extinguishing systems).
(4) To maximize tank integrity, adjacent tanks and piping on deck and in the area should be cooled to prevent explosion and vapor ignition. Cargo piping on deck usually is empty but can contain vapors from the most recent cargo.
(5) The use of fixed systems, such as inert gas, should be considered.
(6) Preparation should be made for downwind evacuation due to plume development.

Since fires involving chemicals can be extremely hot, personnel protection by use of water streams is a viable tactic. Rescue of personnel and movement of hose teams can be hampered by the presence of fixed piping on the decks of vessels. Due to the high volatility and inhalation risk of chemical vapors, adequate personnel protection procedures and equipment should be utilized. It is important to maintain awareness that heat, water, and mixing of chemicals can produce dangerous products; personnel protection is vital.

10.13 Fires in Holds. The holds of a vessel are large areas, below the main deck, in which cargo is stored for transport. Although holds are most often associated with cargo vessels (bulk and break bulk carriers), many vessels contain holds.

To protect the cargo holds, hatches should cover the hold at the main deck and at the tween deck openings. Hatches usually are removed by mechanical means. When the hatches are closed, cargo can be lashed to them. Surrounding the hold is a hatch combing that prevents deck runoff from entering the hold and helps prevent personnel on deck from falling into the hold. There are no combings around the tween deck openings. Access to a hold can be accomplished through large openings in the side of the vessel. Scuttles and ladders, which are closed when the vessel is under way, provide access to the hole.

While attacking a fire in the hold, the following should be considered:

(1) The items that are burning should be determined.
(2) Fixed fire-fighting systems should be determined for that hold.
(3) An attack should be planned (e.g., attack from side opening vs. attack from the hatch).
(4) The side opening should be closed if attacking from the hatch.
(5) Smothering the fire by closing the hatch and, if possible, adding inert gas should be considered.
(6) Exposures and adjoining holds should be continually monitored and protected.
(7) Distributor nozzles and fog nozzles can be placed into the hold (it should be noted that excessive cargo damage or stability problems, or both, could result).
(8) Deck operations can be dangerous because of open hatches and cargo-handling equipment.
(9) The freeboard of the vessel might have to be cooled.

(10) Removal of some cargo should be considered.
(11) Fire in a hold can be difficult to attack because of the large area involved, difficult means of accessing, and poor visibility.

10.14 Machinery Room Fires.

10.14.1 Fire-Fighting Systems in Machinery Spaces. The following fire-fighting systems can be found.

(a) *Water.* The fire-main system with standpipes is the backbone of all fire-fighting systems aboard ships.

(b) *CO_2.* Hose reels are used to extinguish electrical fires in large switchboards. Some of these hose reels have nozzles that are locked in the open position, which allows flooding of the area.

(c) *Installed CO_2 Systems.* Installed CO_2 systems are found in these spaces, but the space should be secured (watertight doors and ventilation) for successful operation.

(d) *AFFF or Other Types of Foam.* One example of fixed foam systems found on board ship is a bilge sprinkling type. It is designed to allow the extinguishment of Class B fires in ship bilges. This system is sometimes found in conjunction with halon.

(e) *Halon.* Fixed flooding systems with halogenated agents have high extinguishing efficiency per unit weight.

10.14.2 Mechanical Systems in Machinery Spaces. The following mechanical systems can be found:

(1) Hydraulic systems
(2) Air compressors
(3) Fuel transfer, service and stripping pumps, centrifugal purifiers, and fuel heaters
(4) Fuel systems, storage and service tanks
(5) Lube oil tanks
(6) Steam systems
(7) High-pressure, low-pressure, and bleed-air systems
(8) Air-conditioning systems
(9) Sewage treatment holding tanks
(10) Electrical

10.14.3 Common Causes of Fire in Machinery Spaces. Common causes include the following:

(1) Oil spray (these fires often occur during maintenance of flanges and valves)
(2) Major oil leak
(3) Electrical systems
(4) Improper storage of combustible materials

10.14.4 Personnel Rescue. Due to varied arrangements and the equipment found in machinery room spaces, search and rescue operations are extremely difficult and hazardous.

Assistance from the ship's crew might be necessary to safely overcome hazards such as high-pressure steam leaks, electrical shock, rotating equipment, and difficult access.

10.14.5 Fire Confinement.

10.14.5.1 Complete electrical power isolation is difficult due to the number of cables within the affected space. All electrical equipment should be secured prior to entry into the affected area. This can be accomplished at the ship's emergency switchboard, load center, or distribution panel.

10.14.5.2 The mechanical systems, tanks, and machinery that can contribute to the fire should be isolated.

10.14.5.3 The boundaries should be cooled. The surrounding areas (e.g., hot spots, discoloration of paint, combustible and flammable materials) should be checked.

10.14.5.4 Working with the ship's master, ventilation should be established.

10.14.5.5 In unaffected machinery spaces, positive ventilation (supply on high, exhaust off) should be established. This is intended to prevent smoke from entering unaffected spaces.

10.14.5.6 The extension of fire in the overhead generally is faster on board ship. Therefore, entry into machinery spaces should be made at the lowest point possible (e.g., escape trunk, shaft alleys).

Entry into affected areas usually necessitates the use of foam. Once in the space, the primary purpose of entry is to extinguish the fire, to ensure that fire sources are secured (fuel oil, lube oil systems), and to cool spaces. All flammable liquids should be covered with foam. Fuel oil and lube oil tanks should be cooled. Care should be taken that water from the cooling lines does not destroy the foam blanket.

10.14.6 Dewatering. While fire-fighting procedures are in progress, efforts should be made to establish dewatering in operations. The ship's systems should be used.

The use of a barge into which fire-fighting waste water can be discharged should be considered.

10.14.7 Points to Consider when Combating Machinery Space Fires. The following are special concerns in machinery space fires.

(a) *Low-Pressure Air.* Some of the shipboard's low-pressure air line joints might be assembled with soft solder and can separate in a major fire. This separation results in a blowtorch effect that can enhance the fire.

(b) *Cables.* Because of the large number of cables that transit a compartment aboard ship, there is a very good possibility that fire fighters also will have to combat a cableway fire.

(c) *Steam.* Because of the inability to ventilate, the temperatures in the space can be extremely high. If the attack team does encounter this situation, it is recommended that the handlines be used at the absolute minimum volume. Large volumes of water, especially from fog nozzles, result in high production of steam.

(d) *Thermal Imager.* If available, this piece of equipment could prove to be extremely valuable while dealing with any shipboard fire.

(e) *Sheared Metal/Metal Turnings.* These can result in a Class D fire (combustible metals). This possibility should be kept in mind.

10.15 Accommodation and Berthing Space Fires.

10.15.1 Rescue. In areas where people live or sleep, the primary concern is the location and rescue of victims. Vessel passenger areas closely resemble a prefabricated housing layout. Some of the similarities are compactness, built-in furnishings, thin walls, low ceilings, narrow hallways, and small doors.

10.15.2 Electrical Power. The electrical power to accommodation spaces needs to be shut off prior to fire-fighting efforts. It should be noted that the removable overhead ceilings contain cableways that might provide power to adjacent spaces. Therefore, the power to the spaces on all six sides of the involved area might need to be shut off. Emergency power is usually of the same voltage on a separate circuit feeding the same fixtures.

10.15.3 Ventilation. It is difficult to ventilate heated fire gases from living quarters below decks without using a combination of horizontal and vertical ventilation. These spaces are not airtight on merchant vessels. However, they might be airtight on military vessels. It is essential that ventilation not be established until a coordinated attack can be made. These spaces retain high heat because of their insulation and, therefore, should be ventilated if fire fighters are to be protected from heat injuries.

10.15.4 Direct Attack. In the early stages of the fire, a quick attack by the ship's crew or land-based fire fighters has proven effective. However, if the fire has been allowed a significant burn time, a sustained effort probably is necessary.

10.15.5 Indirect Attack. Because of the high synthetic fireloading of these spaces, the flashover potential of passenger cabins is normally higher than that of the average house. For this reason, fire fighters should use extreme caution where entering these closed spaces. The use of piercing nozzles should be considered.

10.15.6 Overhaul. The possibility of fire extension in concealed spaces surrounding passenger cabins is usually very high. A thorough overhaul is essential and should include penetration of the bulkheads.

10.16* Gas Tanker Fires. Gas tankers referred to in this section are vessels that are specifically designed to transport flammable gas in bulk liquid form at very low temperature. Nonflammable and essentially nonflammable liquefied gases transported in bulk, such as anhydrous ammonia [ignition temperature −1204°F (−131°C)], can be controlled by methods similar to those used for unignited releases. The two most common liquefied flammable gases are liquefied natural gas (LNG) and liquefied petroleum gas (LP-Gas). LNG is mostly methane, liquefies at −260°F (−162°C), and is reduced in volume 600 times during the gas-to-liquid change. LP-Gas is primarily propane or butane, liquefies at −44°F (−42°C), and is reduced in volume 270 times when liquefied.

10.16.1 Although many of the physical characteristics of LNG and LP-Gas differ substantially, fire-fighting strategies and tactics are similar. Both gases are nontoxic but are asphyxiants. They are often stored similarly aboard vessels in large, insulated, spherical containers (usually five spheres per vessel). The spheres or tanks usually are individually isolated within the hull by a secondary barrier designed to contain low-volume leakage from the tank temporarily or by a primary barrier.

These enclosed spaces, like others that exist aboard the vessel, provide an environment that could promote explosion or fire hazards, or both, from either gas. If escaping into open air, however, both gases are subject to fire, but, generally, only LP-Gas is subject to explosion. An open-air LP-Gas explosion usually necessitates a large liquid-phase release and also depends upon environmental factors such as wind conditions, humidity, terrain, and ignition sources.

10.16.2 Ships that carry LNG or LP-Gas usually have water spray systems throughout critical cargo areas on deck. Although the water spray normally is not used to extinguish the fire directly, it can prove effective in the following:

(1) Dissipating unignited flammable vapors
(2) Protecting metal surfaces subject to brittleness and fracture from cryogenic liquids
(3) Confining a fire to a limited area
(4) Protecting exposures from radiant heat

10.16.3 Most ships also are fitted with sufficient dry chemical units to extinguish a cargo fire on board. Such units include large fixed systems with fixed monitors, smaller skid-type stations, and semiportable wheeled tanks. Generally, crew members are specifically trained to combat liquefied flammable gas fires.

10.16.4 United States ports that regularly handle these gases in bulk are controlled by the USCG Captain of the Port LNG/LP-Gas Vessel Management Plan and the LNG/LP-Gas Emergency Contingency Plan. These plans usually separate gas vessel incidents into two separate categories: those incidents that occur while the vessel is in transit to the facility, and those that occur while the vessel is moored at the facility. Generally, regardless of the nature of the emergency, the plans require that the response always be the same and that the worst situation be anticipated. Various factors, including resource response time and high hazard potential, dictate this approach. The following general guidelines apply to most liquefied flammable gas vessel fires, whether they occur on ships or barges:

(a) All personnel should remain upwind of the release.

(b) High-velocity fog should be used on the vapor of unignited releases. This procedure assists in the dispersion of gas vapors. High-velocity fog can be employed to direct vapors away from an ignition source or toward a more windy area.

CAUTION

High-velocity fog should never be applied to the liquid. It merely accelerates the formation of vapor.

(c) In the event of ignition, water should be used to cool down surrounding tanks, piping, equipment, and structures. It also should be used to cool down the tank involved in the fire. Water spray should be used to protect personnel involved in shutting down the source or protecting exposures.

(d) Normally, gas fires should not be extinguished unless the source can be shut off. A controlled burn generally is preferable to an uncontrolled, unignited leak. Factors for consideration include failure of structural metal from extreme cold (unignited) or extreme heat (ignited).

(e) If it is necessary and practical to move the vessel away from the facility, a delay of at least 30 minutes should be expected, depending on the type of hose connection(s) to the shoreside facility.

Chapter 11 The Incident Command System

11.1 Introduction. As the complexity of an incident increases, additional positions within the incident command system (ICS) need to be activated. The incident commander determines which positions are to be activated. These can include planning, logistics, safety officer, and information officer.

The ICS provides a method for different agencies, organizations, and individuals to work together toward a common goal in an organized, productive, efficient, and effective manner. The ICS consists of procedures for controlling personnel, facilities, equipment, and communications during all phases of an incident. The ICS is designed to evolve from the time an incident begins, through initial attack and stabilization, to long-term control, and, finally, to the resolution of the incident.

The incident command system is adaptable to any vessel incident, whether it is a fire, an explosion, a hazardous material, or other type of incident. It can be utilized for a small fire aboard a vessel involving a single agency such as the local fire department, or it also can be used on a large, complex incident involving a vessel(s) or a terminal, or both.

The structure of an ICS can be established and rapidly expanded, depending on the changing conditions of the incident. The person in charge of the incident could be a company officer, who might be the first on the scene, or it could be the chief of the fire department, depending on the magnitude of the situation.

Solving any problem, especially one as complex as a major vessel emergency, is easier if broken down into parts. Under an ICS, the incident organizational structure develops in a modular fashion, based on the size of the incident. The incident's staff builds from the top down, and additional sections or functions are added as the incident demands. One person usually can manage small incidents, whereas larger operations necessitate independent management of the various command responsibilities.

The ICS allows response agencies to operate within a common, consistent, and preestablished organizational structure and with standard operating procedures. Predesignated standard names and terminology are used for organizational elements. English, rather than complicated codes, is used for radio communications. Incident communications are planned, controlled, and managed using several functional radio networks.

The ICS provides for the rapid activation, utilization, and control of resources.

11.2 Size-up. Any incident begins with the notification that an emergency exists. This sets in motion the beginning of the ICS.

A predetermined amount of emergency equipment and personnel are dispatched to the incident scene. Responding fire officials immediately begin an analysis process called *size-up*. This phase involves gathering facts, data, and information on events that have occurred or are occurring, forecasting future events, and developing a plan of action. This size-up process continues throughout the incident and is subject to constant revision.

En route to the incident scene, fire officers assess their familiarity with the location and the vessel that could be involved, scene conditions, time of day, their personnel situation, and possible resources available. They might consult the fire plans of the vessel and the terminal facility or a preestablished response plan for vessel incidents.

Upon arrival, the first fire official observes the scene and provides input on conditions, such as type of incident, vessel type, vessel name, and incident location. Based on these observations, the call for more assistance in the form of additional alarms or specialized resources might be needed. It can save time if this is pre-established.

Some special size-up considerations should include the following:

(1) Location, status, and condition of the vessel
(2) Collection of the ship's documents and plans
(3) Location of pre-fire plans
(4) Identification of special equipment needed
(5) Level of fire-fighting experience of the crew
(6) Vessel construction
(7) Location of master, mates, engineer, crew/personnel
(8) Status of fuel and ballast tanks
(9) Flooding and stability problems

11.3 Staging. Staging areas should be predetermined for every marine terminal during the pre-fire planning process. Facilities often have piers that will not accommodate fire apparatus. The closest point may be as far as a mile away. This situation will require additional resources and increase the deployment time that is required to respond to a marine incident. The incident commander should designate a staging officer, who should establish the staging area, maintain a log, and maintain communication with the incident commander.

11.4 Command Post. The first arriving fire officer assumes command of the incident and names the command, usually after the name of the vessel, terminal, or location of the incident. This officer establishes a command post (CP) and announces its location.

The command post location should be accessible but safe to prevent its relocation later in the incident. It should be upwind and have an overall view of the incident, if possible. It should be large enough to accommodate all key personnel who are to be involved in the command function. Communications equipment and sanitary facilities are recommended. A nearby terminal or office building is appropriate. The command post is the location from which all incident operations are directed. There is to be only one command post.

The incident commander has the responsibility for overall management of the incident. His responsibilities include staff functions such as the provision of information, safety, and liaison to support the command function. The IC prepares incident objectives that, in turn, serve as the foundation of subsequent action planning. The IC approves the final action plan and all requests for ending and releasing primary resources.

Command keeps track of orders issued, orders in progress, and orders completed. If the vessel has an onboard command post, a representative from the fire department shoreside command post should be sent on board.

11.5 Operations. The operations section supervises the actual control of the emergency. Operations implements the action plan. The operations section can set up in the vessel, in the terminal, or adjacent to the command post. Operations include the following.

(a) The Coast Guard or Harbor Patrol, or both, should establish and enforce a waterside safety zone.

(b) Fire personnel should obtain the following information concerning the vessel's cargo and fire load:

(1) A general cargo management and stowage plan
(2) The advisability of off loading or transferring cargo
(3) A "Dangerous Cargo Manifest," which can be obtained on or near the bridge or terminal office; hazards should be determined, and necessary actions taken

(c) The fire situation and exact location should be determined. Methods include heat scanners (infrared), temperature sensors, observation of red-hot or warped plates, and determination of the areas served by smoking vents.

(d) The compartment or deck involved should be determined. The life hazard and steps necessary to minimize or neutralize it should be determined.

(e) The crew should account for the following:

(1) Personnel on board
(2) Crew list
(3) Crew condition/location
(4) Passenger list
(5) Passenger condition/location

(f) Evacuation needs should be determined.

(g) The following exposures should be evaluated:

(1) Shoreside
(2) Waterside
(3) Other parts/areas of involved vessel
(4) Other vessels
(5) Port facilities, piers, structures
(6) Cargo
(7) Vehicles
(8) People
(9) Environmental/pollution
(10) Other exposures

(h) The ship's systems status and condition should be determined.

(i) Access and egress problems on the shore and the water sides of the vessel should be evaluated.

(j) The water supply should be evaluated for the following:

(1) Drafting sites
(2) Fireboats and apparatus
(3) Floating platforms

(k) Water supply hoselines should be laid from shore to vessel.

(l) Aerial apparatus should be used as standpipes.

(m) The Coast Guard Captain of the Port should be notified to obtain assistance.

(n) Foam supply should be identified and established.

Due to the numerous aspects of a vessel fire that need special consideration by the incident commander, it is recommended that a checklist be developed to assist the IC in managing the incident. A sample vessel fire checklist is provided in Appendix C.

Where a shipboard fire is managed under an ICS, a number of key individuals should be included.

(a) The vessel's master or master's representative should provide particulars of the vessel and its cargo and condition of loading.

(b) The Coast Guard Captain of the Port has authority over marine disasters and is primarily concerned with safety and the effects of emergencies on navigable waters.

(c) Port and terminal representatives can help identify exposures to port facilities as well as provide equipment and crews for assistance.

(d) Passenger vessel pursers and shoreside company officials can assist in accounting for passengers before they leave the scene. An area to which passengers are to report should be designated immediately. Comparisons of this passenger information with that of passengers taken to hospitals can reduce unnecessary entries for search and rescue.

A naval architect/salvage expert can provide continuous monitoring of the vessel's condition, since fire and extinguishment operations can rapidly render a vessel unstable and unsafe.

A certified marine chemist helps to monitor gas concentrations and interior fire area conditions and could help in smothering operations.

A communications officer is needed to coordinate groups who do not share frequencies or systems. There also might be a need to have access to translators for foreign crews.

11.6 Logistics. The logistics section should be developed and expanded to provide, maintain, and move personnel, equipment, and supplies (e.g., equipment maintenance, fuel, food and refreshments, communications, sanitation) to areas where they are needed during the incident. The initial staging area might be designated as a base where the primary support or logistical activities are to be performed.

A logistics officer is needed for large incidents, which pose substantial or long-duration supply problems.

A staging area or equipment resource pool used to stockpile air cylinders, hose, and appliances can be established on the vessel or adjacent to the vessel on the dock for personnel and equipment ready to be assigned to the incident as other personnel are rotated out. It is critical that, once the fire attack has begun, it should continue uninterrupted until the tactical objectives are achieved. If extinguishment operations are interrupted temporarily to mobilize fresh personnel, gains previously made could be overtaken.

Hose attack teams in self-contained breathing apparatus (SCBA) under high heat and difficult access conditions aboard vessels are effective for approximately 15 minutes. Because of this time constraint, a minimum of three teams of personnel should be dedicated for each fire attack hoseline: one operating the hoseline, one ready to relieve the attack team, and a third team changing its air cylinders and preparing to be operational again. Each attack team should have a minimum of two $1^1/_2$ in. (38 mm) or $1^3/_4$ in. (44.5 mm) hoselines. This provision allows one for fire attack and one for personnel heat protection (wide fog).

Shipboard fire fighting demands long travel distances through the vessel's passageways and from deck to deck before reaching the actual fire. These pathways can be charged with heat and smoke. Fire fighters might need to utilize SCBA while walking through the vessel. The logistics section should consider the amount of air that can be consumed while traveling to and from the fire. Forward staging areas for stockpiling air cylinders should be established at locations that do not exceed 20 minutes of travel time between such locations. Wherever possible, forward staging areas should be free of smoke and contamination to facilitate the safe changing of cylinders.

Logistics should develop a system to mechanically transfer equipment and supplies (e.g., hose, appliances, air cylinders, foam) from the dock to the vessel using the vessel cargo-handling gear, winches or cranes, and transfer lines from the dock. Logistics is responsible for maintaining the incident radio communications systems. A minimum of three radio networks should be utilized. A command network for the incident commander, command staff (safety liaison, information), general staff (operations, logistics, and planning) and branch, divisions, and group supervisors should be established. A tactical network for operations and the various divisions and groups communicating with each other also is needed. Lastly, a support network should be provided for logistics to utilize in order to control the supply of resources and other nontactical functions. There also might be a marine channel for control of waterside activities involving the Coast Guard and fireboats and an air operations channel for helicopter activities.

A rehabilitation area should be established close to the incident, but in a safe area, so that fire crews can be rotated out for rest and refreshments. Relief agencies often can assist in this effort. This area, along with the staging and base, should provide personnel with some protection from the weather. Logistics might assign specific officers to manage key areas, such as water supply, foam, air, and cylinders.

11.7 Manageable Units. Operations should divide the incident into manageable units that can be designated as *divisions*, *groups*, *branches*, or *sectors*.

Divisions are used to split the incident into manageable geographic areas and are assigned personnel, equipment, and a supervisor to perform activities needed in that area. For example, each involved deck could be a division with two to three fire companies performing all needed activities in that area under the direction of a division supervisor. Areas would be designated "main deck division," "second deck division," and so on. The incident could be divided by fire boundaries such as "forward division," "aft division," and "deck division."

Operations also can divide the incident functionally into units called *groups*. Tactical objectives or tasks can be assigned to several fire companies under the direction of a group supervisor. Some examples include rescue, evacuation, triage, ventilation, dewatering, salvage, and exposure protection.

If the number of divisions and groups exceeds the officers' span of control, branches can be utilized to further divide the incident organizationally into manageable areas. Divisions and groups can be assigned to various branch commanders. Examples include a vessel branch for all activities aboard the vessel, a dock branch for all tactical activities on the dock, and a marine branch for the waterside activities.

11.8 Planning. A planning section should be established near the command post to collect, evaluate, and disseminate tactical information on the incident. This is where the ship's blueprints, plans, and pre-fire surveys are used by technical specialists who prepare primary and secondary action plans. This section also maintains accurate records and documentation on resources and the chronological progression of the incident.

11.9 Emergency Medical System. An emergency medical system needs to be established if there are victims. Fire personnel can provide immediate first aid and removal from dangerous areas. An organization under the ICS should be established to conduct triage and transportation of the injured. These functions can be handled and staffed by fire, EMS, and public health officials, or a combination of these.

11.10 Miscellaneous. Once the rescue of injured or endangered persons has been addressed, the ICS protects exposures and sets up fire boundaries to contain the fire. This involves utilizing personnel and equipment to accomplish the following:

(1) Position water streams on all sides of the fire to cool the hull, bulkheads, overheads, and decks.
(2) Secure all ventilation system ducts, fans, and dampers to the fire area.
(3) Isolate, secure, and stop all fuel flow to machinery located in the fire area or threatened by the spread of fire. However, some exceptions can exist, such as emergency generators and emergency diesel fire pumps.
(4) Close all vertical and horizontal openings, such as watertight doors, fire doors, ports, and hatches to the fire area.
(5) Move all combustibles away from bulkheads and decks adjacent to the fire area.
   a. The nearest complete bulkhead on the deck of the fire should be identified as the primary fire boundary.
   b. A secondary boundary should be identified in case the fire escalates and compels suppression forces to retreat.
(6) Control and secure electrical power to the fire area.
(7) Identify and continually investigate all concealed spaces and avenues of fire spread through fire boundaries.
(8) Make frequent inspections of all sides of the fire to ensure primary fire boundaries are holding.
(9) Make arrangements for portable mechanical ventilation and portable lights, if necessary.
(10) Monitor vessel stability early in the incident.
(11) Determine the critical list and note the inclinometer reading on the bridge; calculate the amount of water going in and coming out of the vessel.
(12) Begin salvage operations, if necessary.

Chapter 12 Role of the U.S. Coast Guard

12.1 Legal Responsibility of U.S. Coast Guard. In discussing fires aboard vessels, one of the questions most often asked is, "What is the Coast Guard's fire-fighting responsibility?" It is beneficial for all agencies to know and understand this responsibility in order to provide a greater understanding of the type of Coast Guard support available and the circumstances under which it can be obtained. It is important to understand the jurisdictional issues that surround marine incidents. A fire department's jurisdiction may continue beyond the shoreline and out to the municipal line. This jurisdiction may correspond with the county and state lines that may go as far as three miles offshore on oceans and much farther in lakes and bays. Departments should ensure that they are aware of the extent of their jurisdiction and commensurate responsibilities. The following is the Coast Guard's marine fire-fighting legal responsibility and enforcement policy, as stated in the *U.S. Coast Guard Marine Safety Manual*, Volume VI, Chapter 8:

"AUTHORITY. Among the provisions of the Ports and Waterways Safety Act of 1972 (PWSA) (33 U.S.C. 1221 et seq.) is an acknowledgment that increased supervision of port operations is necessary to prevent damage to structures in, on, or adjacent to the navigable waters of the U.S., and to reduce the possibility of vessel or cargo loss, or damage to life, property, and the marine environment. This statute, along with the traditional functions and powers of the Coast Guard to render aid and save property [14 U.S.C. 88(b)], is the basis of Coast Guard fire-fighting activities. 42 U.S.C. 1856-1856d provides that an agency charged with providing fire protection for any property of the United States may enter into reciprocal agreements with state and local fire-fighting organizations to provide for mutual aid. This statute further provides that emergency assistance may be rendered in the absence of a reciprocal agreement, when it is determined by the head of that agency to be in the best interest of the United States."

"POLICY. The Coast Guard has traditionally provided fire-fighting equipment and training to protect its vessels and property. Captains of the Port (COTP's) are also called upon to provide assistance at major fires on board other vessels and waterfront facilities. [NOTE: COTP's are Coast Guard Officers, authorized by Congress [14 U.S.C. 634(a)] to be designated by the Commandant of the Coast Guard, to facilitate execution of Coast Guard duties prescribed by law.] Although the Coast Guard clearly has an interest in fighting fires involving vessels or waterfront facilities, local authorities are principally responsible for maintaining necessary fire-fighting capabilities in U.S. ports and harbors. The Coast Guard renders assistance as available, based on the level of training and adequacy of equipment (i.e., Coast Guard personnel and equipment). The Commandant intends to maintain this traditional 'assistance as available' posture without conveying the impression that the Coast Guard is prepared to relieve local fire departments of their responsibilities.

Paramount in preparing for vessel or waterfront fires is the need to integrate Coast Guard planning and training efforts with those of other responsible agencies, particularly local fire departments and port authorities. COTP's shall work closely with municipal fire departments, vessel and facility owners and operators, mutual aid groups, and other interested organizations. The COTP shall develop a fire-fighting contingency plan which addresses fire-fighting in each port within the COTP zone. This plan should be organized in a format similar to the federal local pollution plan as required by the *National Oil and Hazardous Substances Pollution Contingency Plan* (NCP) (40 *CFR* 300.43)."

12.2 Available Resources. The Coast Guard's "assistance as available" policy is in keeping with long-standing policies of the Coast Guard and should not be construed as providing less assistance than in the past. The Coast Guard is an important resource available to fire-fighting organizations because of its fire-fighting contingency plans that are developed for each port and their maritime authority within each port area. The contingency plans are vital to the effective coordination of fire-fighting efforts on vessels in port. In this regard, the Coast Guard is, in fact, providing greater assistance than in the past. These contingency plans are discussed in more detail later.

12.3 Personnel. Coast Guard personnel who can be helpful to local fire-fighting agencies include the following:

(1) Marine inspectors
(2) National strike teams
(3) Coast Guard reserve fire and safety technicians (FS)
(4) Marine fire-fighting coordinators
(5) The COTP or COTP representative

Marine inspectors are assigned to the inspection department of a marine safety office (MSO) who are familiar with construction, equipment, and operating procedures for various types of vessels.

The National Strike Force is composed of the Pacific Area Strike Team and the Atlantic Area Strike Team (which includes the Gulf of Mexico). These teams have expertise in oil and hazardous substance removal and in vessel damage control.

The FS is a Coast Guard reservist who is a specialist fully qualified in the fields of marine fire protection, prevention, and fire suppression; hazardous material storage and transfer; and pollution incident monitoring, supervision, and investigation.

The marine fire-fighting coordinator, usually a Coast Guard FS, provides the COTP with expertise and advice during a fire-fighting situation. This individual, due to the requirements of this Coast Guard Reserve rating, is usually a local civilian fire fighter.

The COTP is the Coast Guard officer responsible for administering and enforcing the Port Safety and Security Program, Marine Environmental Response Program, and Waterways Management Program within the boundaries of a specific COTP zone. The COTP has the authority (based on the Ports and Waterways Safety Act, 33 USC 1221) to order a vessel to operate or anchor in a specific manner, in the interest of safety, due to a temporary hazardous circumstance or the condition of the vessel itself.

12.4 Equipment and Supplies. The Coast Guard does not stock large quantities of fire-fighting supplies at either its offices or on board its vessels. It relies upon local agencies and vendors for this support. Coast Guard vessels that have fire-fighting support capability that might be available to fire response agencies are variously sized utility boats with outboard motors, the 32 ft ports and waterways boat (PWB), the 41 ft patrol boat (UTB), and the 44 ft motor life boat (MLB).

12.5 Equipment Limitations. Coast Guard boats operate within the inland and coastal waters. Cutters (larger than boats) operate on the coastal waters and high seas. Their fire-fighting capabilities generally are more substantial, but, due to their operational commitments, they cannot always be made available. If they are available, their fire-fighting systems are designed for combating fires on board and are limited.

12.6 Training. The Coast Guard training available to local fire-fighting agencies is limited and varies from zone to zone. Within each zone, the COTP is encouraged to conduct training in marine fire fighting for Coast Guard and other personnel. The marine fire-fighting coordinator usually is responsible for this program, which might involve exercising of the Marine Fire-fighting Contingency Plan. Due to resource limitations, formal training is generally limited to Coast Guard personnel. The Coast Guard does not approve marine fire-fighting courses for the land-based fire fighter. There are, however, Coast Guard–approved marine fire-fighting courses for the merchant mariner. These courses can be made available to land-based fire fighters so that they become familiar with marine fire fighting.

12.7 Contingency Plan. The Coast Guard has the role and responsibility for developing the fire-fighting contingency plans for the ports in the geographical area for which the COTP is responsible. This process usually begins with the COTP organizing a task group comprised of all interested and involved members of the port community. The Coast Guard then provides the coordination and direction for the development of the contingency plan. The task group usually sets the parameters that it intends the plan to cover but is guided by the basics as outlined by the Coast Guard. Some of the best plans are those that have allowed task group members to exercise imagination and thoroughness. The following is the sample outline for a contingency plan found in the *U.S. Coast Guard Marine Safety Manual*, Vol. 6, Chapter 8:

- Letter of Promulgation
- Record of Amendments
- Table of Contents
- List of Effective Pages
- Introduction
  - Authority
  - Purpose and Objective
  - Scope
  - Abbreviations
  - Definitions
- Policy and Responsibility
  - Federal Policy
  - Related State Policy
  - Multinational Policy
  - COTP Responsibility
  - Nonfederal Responsibility
- Planning and Response Considerations
  - Transportation Patterns
  - Waterfront Facilities
  - Historical Considerations

Hydrological and Climatic Considerations
Local Geography
Highly Vulnerable Areas
Local Response Resources
Political Considerations
Response Organization
Predesignation of Responsibilities for Various Scenarios
Organization Charts
Operational Response Actions
Command, Control, and Communications
Coordination Instructions
Delegations of Authority
Notifications
Coordination with Special Forces
Termination of Response Activities
Resolution of Disputes
Procedures for Reviewing, Updating, and Exercising
Responsibility
Exercises
Annexes
Distribution
Response Personnel Assignments
Geographical Boundaries
Notifications and Communications
Public Information
Documentation
Funding
Response Techniques and Policies
Arrangements for Volunteer Groups
Interagency Support
Geographical/Action Directory
Response/Assistance Directory

Because of the interdependency of personnel involved in a contingency plan, these plans need the signatures of the appropriate authority from each agency. A thorough contingency plan is a major undertaking that takes time and effort to produce. The plan needs to be tested to confirm that it works. A plan should be tested often enough for those currently involved in its execution to be familiar with their roles and responsibilities.

12.8 Fire Fighters and the Vessel Master. The relationship between local fire fighters and the master of a vessel is critical for the successful extinguishment of a vessel fire. It is the Coast Guard's policy that the presence of local fire fighters does not relieve the master of command or transfer the master's responsibility for overall safety on the vessel. However, the master should not countermand any orders given by the local fire fighters in the performance of fire-fighting activities unless the action taken or planned clearly endangers the safety of the vessel or crew.

12.9 Fire Fighters and the Coast Guard. The Coast Guard COTP is responsible for the safety and security of the port. The COTP is interested in any incident that could endanger the port. The COTP's role at a vessel fire is not to direct the fire-fighting efforts but to ensure that efforts do not threaten port safety and security. Due to authority based in law, the COTP directs the movement of a vessel. This authority can be very helpful to the fire fighter in fire-fighting efforts.

12.10 Marine Safety Office. Most Coast Guard captains of the port are located within a field organization called the marine safety office (MSO). The commanding officers of the MSO are the COTP and the officer in charge of marine inspections (OCMI). The chief of the Port Operations Department at the MSO is the local Coast Guard liaison for port fire-fighting efforts and contingency planning.

12.11 Jurisdiction. The fire-fighting activities of the Coast Guard are based in the Ports and Waterways Safety Act of 1972. This authorizes the Coast Guard to prevent damage to structures in, on, or adjacent to the navigable waters of the U.S. The navigable waters of the U.S. are defined in 33 *CFR* 2.05-25 as follows:

(1) The territorial seas of the U.S. (*see below*)
(2) The internal waters of the U.S. that are subject to tidal influence
(3) The internal waters of the U.S. not subject to tidal influence that:
   a. Are or have been used for interstate or foreign commerce, or
   b. Are capable of use for interstate or foreign commerce, pending improvement.

The territorial seas are those waters within the belt, 3 nautical miles wide, that is adjacent to the U.S. coast and seaward of the territorial sea baseline (depicted on most charts).

The USCG's authority on the Great Lakes ends at the Canadian border.

Chapter 13 Problems Associated with Marine Fire Fighting

13.1 Press and Media Relations. As with any incident command system (ICS), the fire officer involved with a marine fire or emergency should designate a press relations officer. However, in the case of marine fires, there is a strong international interest. Astute marine fire incident commanders arrange for their own interpreter in order to reduce the possibility of translation errors. As soon as possible, as part of the unified command, a joint information center should be established. This will reduce the burden on the IC and ensure that accurate information is being communicated.

13.2 Hazardous Materials. Every vessel response should initially be treated as a hazardous materials incident. Incident commanders should ensure that a hazardous materials response unit responds on each incident or is immediately available. In addition to hazardous cargo, vessels carry a variety of hazardous materials as ship's stores. These materials may be stored anywhere on the vessel. During fire incidents, it must be assumed that any compartment may contain some form of hazardous material. Ship's stores are not required to be marked, labeled or placarded, nor will there be material safety data sheets available.

Hazardous materials officers preparing plans for maritime incidents should be aware of the locations of the cargo stowage plans for the vessels that enter their port. They also should be aware that there are many different hazardous material container marking systems used throughout the world. They should become familiar with the system(s) that is expected to impact them during a marine incident in their response area. The following documents should be referenced:

(1) Safety of Life at Sea, 1974, Chapter VII (SOLAS, 1974)
(2) International Maritime Dangerous Goods (IMDG) Code
(3) Title 49, *Code of Federal Regulations*, Parts 100–177
(4) *International Conference on Marine Pollution*, 1973, Annex II, Appendices I through IV, Resolutions 12, 13, 14, and 15

Though hazardous materials are required by law to be marked, placarded, or documented, they are not always identified properly. This should be kept in mind when reviewing cargo.

13.3 Pollution Considerations. The risk of water pollution in marine fires usually is significant. Fire officers should consult Coast Guard representatives to ensure that fire-fighting actions do not unnecessarily aggravate the problem. The pollution impact associated with fire-fighting operations can easily exceed the impact from the fire. In addition, with the advent of the Oil Pollution Act of 1990, federal funds may cover fire department costs if they reduce or eliminate the potential for an oil spill. This usually requires the notification of the Coast Guard, to ensure federal requirements are met.

13.4 Language Barriers. Most of the vessels sailing to and from U.S. ports are foreign flag ships. In many cases, the crew might not speak English. Fire-fighting plans for marine areas should have lists of interpreters who are available at all times to assist with communications. Interpreters can often be found at universities, at many large international companies, and in the employ of shipping agents.

13.5 Vessel Movement. The movement of any vessel that is on fire should be undertaken with great caution. It should not be assumed that the vessel can move safely under its own power. Tugs should be present to assist the vessel, even if the ship's engines are functional. If necessary, a pilot should direct the vessel's movement. Regardless of the risk to shore facilities, vessels should not be cast free to drift with the current. Any fire vessel movement should be coordinated between the ship's master, COTP, port authority, pilot, and incident commander.

Chapter 14 Post-incident Activities

14.1 Vessel Disposition.

14.1.1 Fire Extinguished. Once the fire is extinguished, the chief fire officer involved in a marine incident might be asked to certify that the danger has passed. A complete overhaul of a vessel can take many hours or even days. Incident commanders are cautioned to avoid a hasty decision when certifying that a fire has been extinguished.

14.1.2 Safe Entry. Frequently, after the fire is extinguished, fire officers involved in marine fires are asked if the fire area is safe for entry by non–fire fighters, civilians, or crew. The marine industry has had numerous fatalities resulting from entry into toxic or oxygen-deficient atmospheres after a fire. As a result, the industry has developed certifications for marine chemists who are recognized and accepted by courts as competent to test and certify that spaces are safe for human entry. Fire officers are strongly advised to leave safe entry decisions to marine chemists.

14.1.3 Vessel/Scene Control. If the master or crew, or both, remain on the vessel, they remain in control of the vessel. The chief fire officer involved in a marine fire or incident might believe that a vessel presents a continued hazard but might have no authority to act. These reservations should be voiced to the master in front of documented witnesses, and, if mitigating action is not taken, such reservations should be referred to the COTP for appropriate action.

14.2 Fire Watch. It is a common practice in marine fire fighting to post fire watches on vessels that have experienced fires. This usually is done during and after the overhaul. Normally, fire watches are positioned on the fire deck as well as on the decks above and below. Fire watches are rotated in shifts and can be maintained for 48 hours or longer. Additionally, the ship's hoselines are laid out (and charged), ready for use in case the overhaul effort proves to be insufficient.

Chapter 15 Legal Issues

15.1 Admiralty Law.

15.1.1 Court Authority. Questions of admiralty law are not within the province of local courts. State courts can adjudicate admiralty matters if the Congress has not and if the body of water or shoreline falls entirely within that state. Under Article I, Section 8, and Article III, Section 2, of the Constitution, Congress is given the power to legislate admiralty and maritime matters and the federal courts are given the judicial power. The U.S. Congress has vested admiralty jurisdiction exclusively in the federal district courts (Amer. Juris. 2d., 1962).

15.1.2 Repercussions. Many fires on ships result in a high monetary loss and sometimes a loss of life. As a result, court actions are brought in admiralty court to address the interests of those who have suffered a loss. In many cases, fire departments, both volunteer and career, as well as mutual aid departments have been the defendants in these cases. An understanding of the dangers inherent in marine fire fighting should include an understanding of the consequences of the failure to provide a standard of training, planning, response, and action equivalent to that which a department provides on the land-based portions of its response area.

15.2 Legislation. The following are examples of legislation that are applicable to marine incidents:

(1) York-Antwerp Rules (1864). Provides for uniform international procedures in adjusting liability
(2) Harter Act (1893). Concerned with U.S. domestic water common carrier liability
(3) Hague Rules (1924). Concerned with international water common carrier liability
(4) Carriage of Goods by Sea Act (COGSA) (1936). U.S. law that was written as a result of the Hague Rules and concerned with the international water common carrier liability in U.S. courts
(5) Oil Pollution Act (1961). Revision of the 1924 act that prohibits the discharge of oil or its by-products in the navigable waters of the U.S. or within 50 mi (85 km) of the coastline
(6) Ports and Waterways Safety Act, 33 *CFR* 10; 33 USC 1221 *(See Section 12.11.)*

15.3 Jurisdiction. The admiralty court jurisdiction can be determined by two important considerations: the wrong is to have occurred on navigable waters and the wrong is to have occurred on a vessel in those navigable waters. A "vessel" is any structure that has the characteristic of mobility rather than being fixed (Amer. Juris., 1962).

15.4 Force Majeure. Force majeure is a concept of International Customary Law that provides that a vessel in distress may be permitted to enter a port and can claim "as a right an entire immunity" from local jurisdiction (Jessup, 1927). It should be noted that admiralty courts have upheld this concept as long as the distress was real and valid. Some foreign admiralty laws hold that force majeure makes exceptions of all rules.

15.5 Negligence. Most cases reaching court accuse some form of neglect. In other forms of law, the doctrine of contributory negligence is used. However, in admiralty court, "the doctrine of comparative negligence prevails." The Rule of Divided Damages is a specialty in admiralty law (Amer. Juris., 1962). Normally, "gross negligence" or "willful misconduct" results in an award of damages (Gilmore, 1975).

15.6 Salvage. In admiralty law, salvage is the award of compensation to a salvor for services rendered to a vessel in distress. These services normally substantially improve the distressed vessel's condition. Where considering an award of salvage, admiralty courts look at the status of the salvor (amateur or professional) and whether the aid was requested or self-initiated (Mankabady, 1978).

15.7 Salvors. Under admiralty law, anyone who renders assistance to a vessel in distress on navigable waters may be permitted to be called a salvor. A salvor is not always entitled to an award of salvage (Sohn, 1984).

15.8 Duty to Act. A true salvor's acts are voluntary; therefore, a person or persons under a duty to render assistance may not be permitted to be awarded claim for salvage in admiralty court (Gilmore, 1975).

15.9 Salvage and Fire Fighters. "Municipal or other public employees, such as firemen, are not entitled to an award for saving property if they were merely performing their regular duties." (Fireman's Charitable Assn. vs. Ross, 60F. 456; 5th. Cir. 1893)

15.10 Port Authority Documents.

15.10.1 Port Regulations. Many U.S. ports have regulations that govern the activities of foreign vessels in their port. It is usually understood that vessels wishing to enter these ports are to conform to these regulations. Fire officers should ensure that their marine fire-fighting plan does not contradict these regulations. It is extremely advantageous if the port regulations support or reiterate the command activities outlined in the plan and delineate the authority of the incident commander.

15.10.2 Port Tariffs. Some port tariffs also put forth regulations to be followed by visiting vessels. They can be employed in the same manner as port regulations. Also, port tariffs provide a source of income for port authorities. This source of income can be used to offset the high cost of providing marine fire protection to vessels using the port.

15.10.3 Contracts for Fire Protection. Some ports contract with local fire departments for fire protection services. These contractual arrangements take many forms and can stipulate actions or prohibitions for the fire department. Chief fire officers should ensure that these contracts do not contradict existing laws, regulations, rules, or customary practices in admiralty law. Contradictions have been known to result in confusion for the fire departments involved (Burns, 1984).

15.10.4 Memoranda of Understanding (MOU). MOU should be used between agencies whose responsibilities are not otherwise defined in regulation or law. Mutual aid agreements can fall into this category. These documents should define the expected actions of the agencies involved and stipulate the desired level of response to marine fires.

15.10.5 Lloyd's Open Form (LOF). This is a standard form document used in the shipping industry to cover salvage agreements between vessels and salvors. It is approved and published by The Committee of Lloyd's. A primary consideration of LOF is the concept of "No cure — no pay." This salvage agreement stipulates arbitration, appeals, maritime liens, cargo disposition, interest rates, liability, and remuneration (LOF, 1980).

15.10.6 Legal Support. It is recommended that a chief fire officer concerned with the preparation of or reaction to plans related to maritime fire and emergency response have the plans reviewed by an attorney who is familiar with, and preferably admitted to the practice of, admiralty law. Ports usually retain attorneys that can provide these services.

15.10.7 Fire Cause Investigation. Fire officers concerned with a cause and origin investigation on a vessel (especially foreign flag vessels) should be prepared to place their personnel or federal officers on fire watch if they intend to maintain scene control to preserve a chain of custody. If the master or crew rejects an investigation, nonfederal fire officers should consult federal authorities (USCG COTP) for direction. Local fire officers should not assume they have the same control of a post-fire scene that they have on land. The U.S. Marshal, insurance carrier, or flag country might wish to assume control of any or all investigations.

15.11 Insurance. Marine insurance was established about 800 years ago, long before fire or life insurance. Modern underwriting insurance had its origins centered around the coffeehouse of Edward Lloyd in London in the middle 1700s. It wasn't until the 18th century that marine insurance was written in America. Generally, insurance allows the price of commodities and services to be less expensive because it allows the shipowner or shipper to spread the burden of losses to a larger group of people, the underwriters.

15.12 Relationship of Fire Chief with Ship Master. Many COTP Marine Firefighting Contingency Plans contain the text of 15.12.1 and 15.12.2 or similar text.

15.12.1 "Fire Department. Within the limits of the fire department's jurisdiction it will respond to all notifications of fire as manpower, equipment, and training allows. This includes marine facilities located within its boundaries and vessels moored alongside those facilities. Further, it may involve fighting a vessel fire occurring in portions of the harbor within their jurisdiction." (COTP Contingency Plan, Jacksonville, FL, 1985)

15.12.2 "Master. This plan does not intend to relieve the Master of his command nor restrict his authority concerning normal shipboard operations. However, it must be recognized that the local Fire Chief normally has more experience in the art of fire fighting. In addition, the Chief has the responsibility for the safety of his men and equipment, and to the community, to contain and extinguish any fires. The success of the operation is contingent on one person being in overall charge of the fire-fighting aspects. In the case of shipboard fires, the local Fire Chief will be the person in charge of the fire-fighting operation. The Master plays a very important role in lending his experience and assisting the Fire Chief, which will greatly enhance the successful operation. The presence of the Fire Chief in no way relieves the Master of command of his vessel. However, the Master shall not countermand any orders made by the Fire Chief in the performance of fire-fighting activities. The Master, officers, and crew of the vessel shall assist in the fire-fighting operation. The Master shall be the liaison between the Fire Chief and his crew. He shall furnish, if possible, the Fire Chief with any and all information requested and should provide members of his crew to act as guides. The Master is at all times in charge of and shall control the actions of his crew. In the absence of the Master, the senior deck officer present will act for the Master." (COTP Contingency Plan, Jacksonville, FL, 1985)

Chapter 16 Referenced Publications

16.1 The following documents or portions thereof are referenced within this guide and should be considered as part of its recommendations. The edition indicated for each referenced document is the current edition as of the date of the NFPA issuance of this guide. Some of these documents might also be referenced in this guide for specific informational purposes and, therefore, are also listed in Appendix F.

16.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 11, *Standard for Low-Expansion Foam*, 1998 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 1997 edition.

NFPA 14, *Standard for the Installation of Standpipe, Private Hydrant, and Hose Systems*, 2000 edition.

NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, 1997 edition.

Appendix A Explanatory Material

Appendix A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This appendix contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.3.4 Anchorage. See Section 2.6.

A.1.3.22 COTP. The Captain of the Port has broad powers over all vessels in the area.

A.1.3.32 Fire Control Plan. The plans are to be stored in a prominently marked weathertight enclosure outside the deckhouse for the assistance of shoreside fire-fighting personnel.

A.1.3.34 Fire Warp. Fire warp should be hung from the forward and after ends of the vessel at a position that allows easy retrieval by a vessel for towing; the other end of the fire warp is attached securely to the vessel.

A.1.3.45 International Shore Connection. This connection allows use of the vessel's fire stations and associated hoses. This connection is required on all vessels over 500 gross tons (454 m tons) subject to SOLAS, and on U.S.-inspected vessels over 1000 gross tons (907 m tons). *(See Section 2.13.)*

A.1.3.51 Mooring. Locally, may be used to differentiate between permanently anchored moorings and slips.

A.2.9 See NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, for the requirements for the construction of piers and wharves.

A.2.10 See NFPA 312, *Standard for Fire Protection of Vessels During Construction, Repair, and Lay-Up.*

A.2.13 See ASTM F 1121, *Standard Specification for International Shore Connections for Marine Fire Applications*, for specific technical information for the international shore connection.

A.3.4.3 The engineering and deck departments should have knowledge of the ship's extinguishing systems. This knowledge should include the type and location of the extinguishing agents and the location and operation of the activation systems.

When in port, some ships are staffed by night mates or night engineers who might not be familiar with the vessel because they were hired specifically to perform night watch services.

A.3.5.6.1 For further information on foam systems, see NFPA 11, *Standard for Low-Expansion Foam.*

A.3.5.7 See NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, for further information.

A.5.11 See NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, for further information.

A.10.10.3 See NFPA 11, *Standard for Low-Expansion Foam*, for further information on using foam to attack fires.

A.10.16 See NFPA 306, *Standard for the Control of Gas Hazards on Vessels*, for further information.

Appendix B Pre-fire Survey Guide

This appendix is not a part of the recommendations of this NFPA document but is included for informational purposes only.

B.1 Figure B.1 provides a sample pre-fire survey.

FIGURE B.1 Sample pre-fire survey.

PRE-FIRE SURVEY GUIDE

GENERAL INFORMATION

A. Ship Name: M/V Batterymarch Park

B. General Use: What is the general use of the vessel? Container, bulk, grain, tank, etc.

C. Ship Line: What company owns the vessel? NFPA Lines, Quincy, MA

D. Flag: List the flag of the operator (owner). U.S.A.

E. Language: What is the language normally spoken by the officers (captain, mates, engineers)? English

F. Crew Number: List the number of crew normally assigned. 28

G. Passengers: List the number of passengers for which the vessel has accommodations. Crew + 16

H. General Specifications: Length: 900 ft Beam: 110 ft

Freeboard (empty and loaded): 37/20 ft

Height above the Water (empty and loaded): 97/80 ft

Draft (empty and loaded): 18/35 ft

(If all specifications cannot be found on the ship's plans, obtain them from the chief engineer or mate.)

I. Propulsion: What type of propulsion is used? Slow speed, 8-cylinder diesel

J. Fuels/Capacity: List the types of fuels used and the amount of storage for each.

Diesel fuel bottom tanks and wing tanks — 53,000 bbls

K. Names and Emergency Telephone Numbers of Owner or Agent: List the name and phone number of the person who should be contacted in case of emergency when the master of the vessel is not aboard and cannot be reached.

Capt. Steve Gooblatz (123) 555-4141

L. Night Staffing Practice: List the normal day and night staffing practices. (Does the crew remain aboard and are the night mates used?)

0800–1600 Usually full crew aboard

1600–0800 1 night mate, 1 night engineer (hired from local union hall, not regular crew members)

CONSTRUCTION INFORMATION

A. General Layout: Make a full-page side view drawing showing all deck levels and cargo space locations. This should be a reduction in size (to letter size) of the side view from the ship's plans. It is to be used as a quick reference in this section.

B. Deck Arrangement: Identify the location of the superstructure(s). Also, describe the deck arrangement, both in the superstructure(s) and the rest of the vessel. List the name and location of all decks in the vessel. Identify the general compartmentation on each.

Upper deck — Engineer officers' staterooms, linen locker, ship's office.

(Pre-fire Survey Guide 1 of 7)

FIGURE B.1 ***(Continued)***

C. Compartment Identification System: Describe the method used to identify compartments.

Vessel uses names (numbers, letters, or a combination of these)

(Explain if compartment numbering or lettering has any significance as to its location or contents.)

D. Frame Numbering System: Describe the frame numbering system used. Explain the direction of numbering.

Bow to stern (stern to bow, center to both ends)

(If sections have been added to the ship to lengthen it, note where the break in the numbering system is and what system is used on the modified section.)

E. Fire-Resistive Separations: List the location of all fire-resistive separations. Identify their location by frame number and deck, and state whether or not they extend the width of the ship or are partial.

(Be careful to gather complete information.)

F. Cargo Spaces: List the following information (include other information that would be useful with regard to cargo spaces):

1. The type of space (container, bulk, tank).

   Break bulk & dry bulk upper & lower tween deck, bottom hold.

   Liquid bulk in deep tanks — No. 2 & No. 4 holds.

   Refrigeration — No. 5 hold, upper tween deck.

2. Arrangement (show how many spaces, how they are located, numbering system).

   5 cargo holds forward of main house and 1 cargo hold aft of main house.

   Cargo holds are numbered from fore to aft.

3. Identify access to all cargo spaces.

   Scuttles and ladders P & S of mast trunk.

4. Describe interconnection between spaces. (Are any cargo spaces connected directly?)

   Watertight bulkheads between holds 1 & 2, 3 & 4, and 5 & cofferdam.

   Holds 2 & 3 and 4 & 5 are double holds without divisions.

5. Identify the capacity and volume of each cargo space.

   Between frames 118 & 149, double hatch, upper and lower hold No. 4 tween decks,

   dry cargo (grain 141,022 ft^3; bale 840,080 ft^3), refrigerated cargo 9488 ft^3, (−)5°F,

   liquid ballast 5000 barrels.

(Pre-fire Survey Guide 2 of 7)

FIGURE B.1 ***(Continued)***

6. List the vessel's fuel tanks, location, and capacity.

Hold/Location	Capacity (barrels)
1F Center deep	4000
1A Center deep	6000
4F Starboard deep	4000
4A Starboard deep	4000
4F Port deep	2000
4A Port deep	2000
1 Double bottom stbd.	600
1 Double bottom port	600
2 Double bottom stbd.	1000
2 Double bottom center	2000
2 Double bottom port	1000
3 Double bottom stbd.	2000
3 Double bottom center	2500
3 Double bottom port	2000

Hold/Location	Capacity (barrels)
4 Double bottom stbd.	2000
4 Double bottom center	1500
4 Double bottom port	2000
5 Double bottom stbd.	2000
5 Double bottom center	1500
5 Double bottom port	2000
6 Double bottom stbd.	900
6 Double bottom center	1200
6 Double bottom port	900
7 Double bottom center	1500
5P Deep tank stbd.	2000
5 S Deep tank stbd.	2000
Total	**53,200**

7. Describe how to remove hatches. Ship has the equipment on board. Folding accordion on rails — boom hoist cables and controls — pull open or close hatch covers.

G. Machinery Spaces: List the following information pertaining to the engine room/machinery spaces.

1. Location — the forward and after limits by frame number, upper and lower limits by deck. FR 95/115, Floor to upper deck (02 Level).
2. Access — possible accesses and where they are located. The doors on the port and starboard sides in the passageway on the upper deck.
3. A brief description of what the space contains. Oil-fired boiler, turbines, generators, etc.
4. Fire Pumps — the location of all fire pumps by frame numbers, deck, and compartment. FR100 starboard, 3rd deck, machinery room.
5. Switchboards — the location of switchboards. FR100 center, 2nd deck, machinery room.
6. The location of "day" or "service" tanks. Port, 3rd deck, machinery room below companionway.
7. The location and nature of significant hazards to fire-fighting operations. Steep ladders and narrow galleries with expanded metal decking four levels deep.

(Pre-fire Survey Guide 3 of 7)

FIGURE B.1 ***(Continued)***

H. Accommodations: Describe briefly the general arrangement of all accommodations.

Deck	Accommodations	# Staterooms
Bridge Deck	Emergency generator, swimming pool, radioman, wheel house	
Upper Deck	Engineer officers	11
Boat Deck	Passengers	8
Main Deck	Crews' quarters, talley clerk's office	20
2nd Deck	Galley and stores	
3rd Deck	Machinery space and holds (refrig.)	

I. Other Spaces: Describe only additional spaces (other than those previously mentioned) that need special instructions.

LOCATION LISTS

A. Data Location: List the exact location of all documents that would be useful during an emergency (e.g., hazardous cargo manifest, cargo manifest, ship's blueprints).

Purser's office — manifests.

Bulkhead, main passageway — blueprints.

Copies are available on bridge.

B. Escape Trunks: List all escape trunks, including location by frame number and compartment at which they originate and terminate.

From shaft alley at frame 204 at the centerline up the second deck.

C. Instruments and Controls: For detailed information on controls, refer to Section IV, "Systems Information." List the exact location of all controls and instruments that might be beneficial during an incident.

Inclinometer — pilot house on bridge, engineering control room

Communications system — wireless radio, telephone, sound power, telephone main controls on bridge

CO_2 systems — main deck

Smoke detection cabinet and annunciators — on bridge

Steam smothering — none

Remote emergency controls

- CO_2 systems — manual system CO_2 room
- Windlass motor room CO_2 — manual system forecastle
- Ventilation — motor control center 2nd deck
- Fuel shutoff — engineer's control room 2nd deck

(Pre-fire Survey Guide 4 of 7)