

Title 46, Code of Federal Regulations, Part 181, "Fire Protection Equipment," 2004.

Title 46, Code of Federal Regulations, Part 183.550, "General Alarm Systems," 2012.

Title 46, Code of Federal Regulations, Part 184, "Vessel Control and Miscellaneous Systems and Equipment," Oct. 2002.

Title 46, Code of Federal Regulations, Part 197, "Marine Occupational Safety and Health Standards," Oct. 2002.

Title 46, Code of Federal Regulations, Parts 24–28 (Subchapter C), "Uninspected Vessels," Oct. 2001.

Title 46, Code of Federal Regulations, Parts 50–64 (Subchapter F), "Marine Engineering," Oct. 2001.

Title 46, Code of Federal Regulations, Parts 175–187 (Subchapter T), "Small Passenger Vessels (Under 100 Gross Tons)," Oct. 2001.

USCG, NVIC (Navigation and Vessel Inspection Circular) 9-97, *Guide to Structural Fire Protection*, 1997.

2.3.9 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2010 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2013 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2011 edition.

NFPA 70®, *National Electrical Code®*, 2011 edition.

NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*, 2010 edition.

NFPA 1405, *Guide for Land-Based Fire Departments That Respond to Marine Vessel Fires*, 2011 edition.

NFPA 1901, *Standard for Automotive Fire Apparatus*, 2009 edition.

NFPA 1906, *Standard for Wildland Fire Apparatus*, 2012 edition.

NFPA 1983, *Standard on Life Safety Rope and Equipment for Emergency Services*, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction

and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents*.

3.3 General Definitions.

3.3.1 Acceptance. An agreement between the purchasing authority and the contractor that the terms and conditions of the contract have been met. [1906, 2012]

3.3.2 Acceptance Tests. In marine fire-fighting vessels, tests performed on behalf of the purchaser by the manufacturer's representative at the time of delivery to determine compliance to the authority having jurisdiction requirements.

3.3.3 Accessible. Capable of being reached for inspection, maintenance, or removal without disturbing the permanent structure.

3.3.3.1 Readily Accessible. Capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, and so forth. [70:100]

3.3.4 Accommodation Spaces. Spaces designed for human occupancy as living spaces for persons aboard a vessel.

3.3.5 Anchor. A device designed to engage the bottom of a waterway and, through its resistance to drag, maintain a vessel within a given radius.

3.3.6 Anchor Chocks. See 3.3.16.1.

3.3.7 Anchor Rode. The line connecting an anchor with a vessel.

3.3.8* Anode. A metal that in an electrolyte assumes a more electronegative charge than the one to which it is coupled. (See also 3.3.15, *Cathode*.)

3.3.9 Bilge. The lowest inner part of a ship's hull. [1405, 2011]

3.3.10 Bitt. Any of the deck posts, often found in pairs, around which ropes or cables are wound and held fast.

3.3.11* Bitter End. That end of a rope or cable that is wound around a bitt.

3.3.12 Boarding Ladder. A device used for boarding a vessel from the water, including handles, rails, ladders, steps, or platforms.

3.3.13* Bridge. The vessel's command and control area, usually enclosed, containing the principal helm, navigation systems, communications systems, and monitoring equipment for the vessel's operating systems.

3.3.14 Category A Machinery Space. Spaces and trunks to such spaces that contain either internal combustion machinery used for main propulsion, internal combustion machinery used for purposes other than main propulsion where such machinery has in the aggregate a total power output of not less than 375 kW, or any oil-fired boiler, oil fuel unit, or oil-fired equipment other than boilers, such as inert gas generators, incinerators, and so forth.

3.3.15* Cathode. A metal that in an electrolyte assumes a more electropositive charge than the one to which it is coupled. (See also 3.3.8, *Anode*.)

3.3.16 Chocks. Usually found on the rail or deck of a vessel, fittings having jaws that serve as fair leads for anchor rode and other lines.

3.3.16.1 Anchor Chocks. Fittings on a deck of a vessel used to stow an anchor when it is not in use.

3.3.17 Class A or Class B Foams. See 3.3.31, *Foam*.

3.3.18 Cleat. Fitting attached to the vessel used to secure an anchor rode or other line to the vessel.

3.3.19 Close-Off Pressure. The maximum pressure the pump is capable of developing at zero discharge flow.

3.3.20 Convenient Reach. In marine fire-fighting vessels, the ability to operate controls without excessive movement from a fixed position such as a seat or safety harness.

3.3.21 Crew. Anyone associated with the onboard operation of the vessel.

3.3.22 dBA. Decibel, "A" scale.

3.3.23 Deck Rail. See 3.3.52, *Life Rail*, *Deck Rail*, or *Lifeline*.

3.3.24 Dynamic Suction Lift. The sum of the vertical lift and the friction and entrance loss caused by the flow through the suction strainers, sea chest, and piping, expressed in feet (meters).

3.3.25* Eductor. A device that uses the Venturi principle to siphon a liquid in a water stream.

3.3.26* Electrolyte. A liquid in which an electric current is easily conducted.

3.3.27 EMS. Emergency medical services.

3.3.28 Fire Hazard Area.

3.3.28.1* Major Fire Hazard Area. Any compartment, space, or duct where the proximity of combustible materials, flammable liquids, and potential sources of ignition can promote a fire.

3.3.28.2 Minor Fire Hazard Area. Includes accommodation, service, and public spaces where the proximity of combustible materials, flammable liquids, and potential sources of ignitions doesn't promote a fire.

3.3.29 Fire Monitor. See 3.3.58, *Monitor*.

3.3.30 Fire-Fighting Vessel. Any vessel whose primary mission is fire-fighting and pumping operations, including emergency operations.

3.3.31* Foam. A stable aggregation of bubbles of lower density than oil or water. [11, 2010]

3.3.32 Freeboard. The vertical distance between the sheer and the waterline.

3.3.33 Gallon U.S. Standard. 1 U.S. gal = 0.833 Imperial gal = 231 in.³ = 3.785 L. [58, 2011]

3.3.34 Galvanic Corrosion. The corrosion that occurs at the anode of a galvanic couple caused by the flow of ions between dissimilar metals in an electrolyte and electron flow within the dissimilar metals.

3.3.35 Galvanic Isolator. A device installed in series with the ac grounding (green, or green with yellow stripe) conductor of the shore power cable to block, in effect, the low voltage dc galvanic current flow, yet permit the passage of ac current normally associated with the ac grounding (green, or green with yellow stripe) conductor. [302, 2010]

3.3.36 Galvanically Compatible. Metals that are close to each other in the galvanic series.

3.3.37 GM. Abbreviation of metacentric height. (See also 3.3.57, *Metacentric Height*.)

3.3.38 gpm. Gallons per minute.

3.3.39 Grab Rail. See 3.3.44, *Handhold Device* or *Grab Rail*.

3.3.40 Ground. The electrical potential of the earth's surface. The boat's ground is established by a conducting connection (intentional or accidental) with the earth, including any conductive part of the wetted surface of a hull. [302, 2010]

3.3.41 Ground Tackle. A general term for the anchor, anchor rodes, and fittings used for securing a vessel to anchor.

3.3.42 Grounded Conductor. In marine fire-fighting vessels, a current-carrying conductor connected to the side of the electrical source that is intentionally maintained at ground potential.

3.3.43 Grounding Conductor. In marine fire-fighting vessels, a normally non-current-carrying conductor provided to connect the exposed metallic enclosures of electrical equipment to ground for the purpose of minimizing shock hazard to personnel.

3.3.44* Handhold Device or Grab Rail. Any fitting, assembly, or device, other than a lifeline or deck rail, that is intended for grasping with the hand.

3.3.45 Hawse Pipe. A cylindrical or elliptical pipe or casting in a vessel's hull through which the anchor rode runs and within which the anchor shank can be housed.

3.3.46* Helm. The position from which direction and water speed of the vessel are controlled.

3.3.47 Hull Potential Monitor. A dc meter that measures the potential of a metallic hull or metallic hull fittings as compared to a reference electrode.



3.3.48* Impressed Current System. A cathodic protection system that uses an external power source to induce a dc electric current through an electrode (anode) that suppresses galvanic corrosion of the craft's hull.

3.3.49 Inclining Experiment. See 3.3.73, Stability Test (Inclining Experiment).

3.3.50 Inflatable Boat (IB). Any boat that achieves and maintains its intended shape and buoyancy through the medium of inflation.

3.3.50.1 Rigid Hull Inflatable Boat (RHIB). Solid-shaped hull mated with a flexible multicompartment buoyancy tube(s) at the gunwale.

3.3.51* Jet Drive. A propulsion unit that generates thrust in reaction to a water stream.

3.3.52 Life Rail, Deck Rail, or Lifeline. A single rail or the entire assembly of stanchions, lines, or rails, including hardware, gates, and so forth, surrounding weather decks and designed to prevent falls overboard.

3.3.53 Limber Holes. Holes in hull framing members to permit draining of liquids.

3.3.54 Line. Rope, when in use. [1983, 2012]

3.3.55 Major Conversion. A change in service of the vessel from some other use to use as a marine fire-fighting vessel.

3.3.56 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning raw materials or components into a finished product. [1901, 2009]

3.3.57 Metacentric Height. A geometric point used to determine stability when related to the center of gravity and center of buoyancy.

3.3.58 Monitor. A fixed master stream device, manually or remotely controlled, or both, capable of discharging large volumes of water or foam.

3.3.59 Monitor Panel. A device that is located at a position remote from the system being monitored (usually at the bridge) and that indicates the condition of the system being monitored.

3.3.60 Moorings. Methods of securing a vessel within a given area.

3.3.61 National Standard Hose Thread (NH). A standard thread that has dimensions for inside and outside fire hose connection screw threads as defined by NFPA 1963, *Standard for Fire Hose Connections*.

3.3.62 Net Positive Suction Head (NPSH) (h_m). The total suction head in meters (feet) of liquid absolute, determined at the suction nozzle, and referred to datum, less the vapor pressure of the liquid in meters (feet) absolute. [20, 2013]

3.3.63* Net Pump Pressure. The sum of the discharge pressure and the suction lift converted to psi or kPa when pumping at draft, or the difference between the discharge pressure and the intake pressure when pumping from a hydrant or other source of water under positive pressure. [1901, 2009]

3.3.64 Personal Flotation Device (PFD). A displacement device worn to keep the wearer afloat in water.

3.3.65 psi. Pounds per square inch. [1901, 2009]

3.3.66 Pump Operator's Position. The location from which the pump operator operates the pump. [1901, 2009]

3.3.67 Rigid Hull Inflatable Boat (RHIB). See 3.3.50.1.

3.3.68 rpm. Revolutions per minute.

3.3.69 Sacrificial Anode System. Galvanic corrosion protection that employs zinc, aluminum, or magnesium anodes connected to the vessel's hull that dissolve away over time.

3.3.70 Salvage. The restoration of a distressed vessel to normal condition, usually the removal of water from inside the hull.

3.3.71 Seaworthy. A vessel's capability to perform its mission in adverse sea or weather conditions.

3.3.72 Sheer. Upper edge of hull exterior at the intersection with the deck.

3.3.73 Stability Test (Inclining Experiment). A test to determine the vessel displacement (light ship survey) and the position of the center of gravity both vertical and longitudinal.

3.3.74 Stem. The most forward portion of the hull.

3.3.75 Thimble. A grooved metal reinforcement fitted snugly into an eye splice of rope to reduce chafing and to spread the tensional loads.

3.3.76 Thruster. Controllable device used to assist in maneuvering and positioning the vessel.

3.3.77 Tonnage. A measurement of enclosed volume of a vessel inside of structural frames (1 ton = 100 ft³).

3.3.78* Ventilation. The changing of air within a compartment by natural or mechanical means. [302, 2010]

3.3.79 Weather Deck. Any deck that is exposed to the weather and normally accessible to personnel and that permits walking or moving around outboard of the superstructure.

3.3.80 Windlass. A mechanical device utilized in the recovery of anchor and chain by vessels following anchoring operations.

Chapter 4 Design Considerations

4.1 General. The vessel shall comply with all relevant governmental regulations governing the design, operation, and navigation of vessels.

4.2 Vessel Performance.

4.2.1 General.

4.2.1.1 The overall performance of a marine fire-fighting vessel shall be permitted to be determined after a careful evaluation of all perceived operational requirements.

4.2.1.2 Elements of performance requiring definition shall include, but are not limited to, speed, range, capacity, endurance, and seakeeping capability, as well as the capability of the fire-fighting system(s).

4.2.1.3 The performance criteria shall be permitted to be defined after the completion of a Determination of Needs Study as described in 4.2.2, or equivalent assessment as determined by the AHJ.

4.2.2 Determination of Needs Study. See also Annex B.

4.2.2.1 Prior to the construction of a new marine fire-fighting vessel or the major conversion of a vessel for fire-fighting purposes, a study shall be undertaken to clearly identify the mission and capability requirements of the vessel.

4.2.2.2 Some of the issues that the study shall be permitted to cover are as follows:

- (1) General specifications as follows:
 - (a) Geographical size of the area to be protected by the vessel
 - (b) Nature of the waterfront facilities and vessels to be protected
 - (c) Maximum desirable response times
 - (d) Maximum wake permissible
 - (e) Nature of the marine environment in which the vessel will operate, including mutual aid operations
 - (f) Anticipated future growth in the service area and the service needs from the marine fire-fighting vessel
 - (g) Projected or anticipated years of service
- (2) Crew — The expected number of personnel in the vessel's crew
- (3) Fire-fighting mission requirements as follows:
 - (a) Requirements for supplying shoreside water systems
 - (b) Number of pier fires in the jurisdiction to which marine fire-fighting vessels have responded or would have responded
 - (c) Number of vessel fires in the jurisdiction to which marine fire-fighting vessels have responded or would have responded
 - (d) Number of land fires in the jurisdiction to which marine fire-fighting vessels have responded or would have responded
 - (e) Maximum expected duration of a mission
 - (f) Pumping capacity used or required during previous major fires
 - (g) Maximum pumping capacity to be reasonably expected of a marine fire-fighting vessel
 - (h)*Minimum pumping capacity for expected handline use
 - (i) Hose and equipment used or required at previous fires by marine fire-fighting vessels
 - (j) Requirements to remain on station during previous fires in the jurisdiction
 - (k) Self protection such as, but not limited to, heat protection, spray, and CBRN
- (4) Rescue and emergency medical services (EMS) requirements as follows:
 - (a) Number of rescue incidents in the jurisdiction in which marine fire-fighting vessels have been involved
 - (b) Type of rescue missions that the marine fire-fighting vessel could become involved with during service life
- (5) Fire prevention requirements as follows:
 - (a) Building inspection requirements
 - (b) Subpier inspection requirements
 - (c) Hazardous cargo inspection requirements
 - (d) Prefire inspection requirements
- (6) Effect of standards and requirements as follows:
 - (a) NFPA standards
 - (b) U.S. Coast Guard (USCG) requirements
 - (c) American Boat and Yacht Council (ABYC) standards
 - (d) Local insurance considerations

4.2.3 Mission of the Vessel.

4.2.3.1 The mission of the vessel shall be defined as a result of the Determination of Needs Study as determined in accordance with 4.2.2.

4.2.3.2 Where the vessel is used for the sole purpose of fire fighting, it shall meet all the stated objectives of this standard.

4.2.3.3 Where the vessel is assigned additional duties, it shall meet all the objectives of this standard, as well as those for each of the designated special operations.

4.2.4 Vessel Requirements Specification.

4.2.4.1 Based upon the outcome of the Determination of Needs Study, the details of the vessel shall be specified.

4.2.4.2 The services of an experienced professional shall be considered to prepare this document and properly define the vessel.

4.3 Command and Control Spaces.

4.3.1 Helm Control Station.

4.3.1.1 All vessels shall have a field of vision from the helm suitable for safe navigation in all operating conditions.

4.3.1.2 Polarized or tinted windows that would interfere with safe navigation shall be prohibited.

4.3.1.3 Machinery, alarm, and monitoring equipment shall be provided at the primary helm or master control station and be adequate for the safe and proper operation of the vessel.

4.3.2 Machinery Control Stations. Vessels that are not equipped with remote controls for machinery shall have an engine room communication system in accordance with 46 CFR 184, "Vessel Control and Miscellaneous Systems and Equipment."

4.3.3 Fire-Fighting Control Centers.

4.3.3.1 Fire-fighting control centers shall provide control of the fire pump and associated remote control equipment.

4.3.3.2 Fire-fighting control centers shall be located in close proximity to the navigation control center.

4.3.3.3 The control center shall provide maximum visual observation of fire-fighting operations.

4.3.3.4 When the control center is to be used as an incident command center, adequate communications for the incident commander shall be provided.

4.3.3.5 Fire-fighting control stations on Type I through Type IV vessels shall be insulated from heat and protected from spray in accordance with the Determination of Needs Study.

4.4 Construction.

4.4.1 General. Placement of equipment shall allow for its removal from the vessel with minimal disruption of permanently installed structural members, or equipment shall be situated to allow for maintenance and repair.

4.4.2 Materials.

4.4.2.1 All parts of the vessel shall be constructed of materials appropriate for the environment in which the vessel will operate.

4.4.2.2 All construction materials for the vessel and the systems shall be selected to minimize the effects of corrosion.



4.4.3 Fuel Tanks.

4.4.3.1 Diesel fuel systems shall comply with *ABS Rules for Building and Classing Steel Vessels*, for Types I and II and ABYC H-33, *Diesel Fuel Systems*, for Types III, IV, and V.

4.4.3.2 Gasoline fuel systems shall comply with ABYC H-24, *Gasoline Fuel Systems*.

4.4.3.3 Portable fuel tanks shall comply with ABYC H-25, *Portable Gasoline Fuel Systems*.

4.4.3.4 The use of liquid hydrocarbon alternative fuels shall be permitted in accordance with accepted industry practices.

4.4.4 Void Spaces.

4.4.4.1 Access and lightening holes shall be arranged clear of concentrated loads or areas of high stresses.

4.4.4.2 Air and limber holes shall be arranged to eliminate air pockets and to avoid any accumulation of water or other liquids.

4.4.5 Open Decks.

4.4.5.1 Openings in weather decks shall comply with *ABS Rules for Building and Classing High Speed Craft* or ABYC H-3, *Windows, Windshields, Exterior Hatches, Doors, Port Lights and Glazing Materials*.

4.4.5.2 All vessels shall be equipped with freeing ports or drains to provide rapid drainage of water, including fire flow, from the weather deck under all operating conditions.

4.4.6 Machinery Spaces.

4.4.6.1 Within practical limits, machinery spaces shall be designed so that all equipment that requires inspection, adjustment, or maintenance is readily accessible.

4.4.6.2 Within practical limits, all equipment shall be arranged so that it is not damaged by bilge water.

4.4.6.3 Compartments in which flammable gases, acid fumes, and oil vapors can accumulate shall be ventilated to reduce the possibility of explosion.

4.4.6.4 Openings and ventilators shall be arranged to minimize risk of water ingress onto equipment.

4.5 Human Factors Engineering.

4.5.1 The vessel shall comply with the requirements in NFPA 302, *Fire Protection Standard for Pleasure and Commercial Motor Craft*; ABYC Standards and Technical Information Reports for

Small Craft; *ABS Rules for Building and Classing Steel Vessels Under 90 Meters (295 ft) in Length*; 46 CFR 24-28, Subchapter C, "Uninspected Vessels," or 46 CFR 175-187, Subchapter T, "Small Passenger Vessels (Under 100 Gross Tons)," as appropriate.

4.5.2 Instructions for operation of vessel safety equipment shall be the equipment manufacturers' instructions and shall be adequately posted.

4.5.3 Escape plans, operating instructions, diagrams, safety checklists, and other pertinent data shall be available to those onboard.

Chapter 5 Classifications

5.1* Classifications. Marine fire-fighting vessels shall be classified and equipped in accordance with Table 5.1 for classification of emergency response vessel resources.

5.2 Requirements for Vessel Classification.

5.2.1 Marine fire-fighting vessels designated as Type I shall meet the following minimum requirements:

- (1) Minimum number of pumps: 2
- (2) Minimum water pumping capacity: 20,000 gpm (80,000 L/min) @ 150 psi (10 bar)
- (3) Foam production in accordance with Chapter 9 of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (4) Minimum number of generators: 2
- (5) On-station fuel capacity: 48 hours
- (6) Minimum number of monitors: 4
- (7) Minimum number of discharge outlets: 24; 6 [1½ in. (38 mm)]; 10 [2½ in. (65 mm) or larger]; 4 [≥3½ in. (89 mm)]; 4 [5 in. (127 mm)]

5.2.2 Marine fire-fighting vessels designated as Type II shall meet the following minimum requirements:

- (1) Minimum number of pumps: 2
- (2) Minimum pumping capacity: 10,000 gpm (40,000 L/min) @ 150 psi (10 bar)
- (3) Foam production in accordance with Chapter 9 of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (4) Minimum number of generators: 2
- (5) On-station fuel capacity: 24 hours
- (6) Minimum number of monitors: 4
- (7) Minimum number of discharge outlets: 8; 3 [≥3½ in. (89 mm)]; 5 [5 in. (127 mm)]

Table 5.1 Minimum Capabilities of Vessel Classification

Component	Type I	Type II	Type III	Type IV	Type V
Pumps	2	2	2	1	1
Pumping water capacity (gpm)	20,000	10,000	4500	1500	500
Foam production	Per Chapter 9 of NFPA 11	Per Chapter 9 of NFPA 11	Per Chapter 9 of NFPA 11	Per Chapter 9 of NFPA 11	None
Generators	2	2	1 with direct power source	0	0
On-station fuel capacity (hours)	48	24	8	6	4
Monitors	4	4	4	2	1
Discharge outlets	Per 5.2	Per 5.2	Per 5.2	Per 5.2	N/A

N/A: Not applicable.

Note: Additional fire-fighting equipment requirements for all types of vessels are found in Chapter 10.

5.2.3 Marine fire-fighting vessels and special purpose fire-fighting vessels designated as Type III shall meet the following minimum requirements:

- (1) Minimum number of pumps: 2
- (2) Minimum pumping capacity: 4500 gpm (18,000 L/min) @ 150 psi (10 bar)
- (3) Foam production in accordance with Chapter 9 of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (4) Minimum number of generators: 1 with direct power source
- (5) On-station fuel capacity: 8 hours
- (6) Minimum number of monitors: 4
- (7) Minimum number of discharge outlets: 4; 2 [$\geq 3\frac{1}{2}$ in. (89 mm)]; 2 [5 in. (127 mm)]

5.2.4 Marine fire-fighting vessels and special purpose fire-fighting vessels designated as Type IV shall meet the following minimum requirements:

- (1) Minimum number of pumps: 1
- (2) Minimum pumping capacity: 1500 gpm (6000 L/min) @ 150 psi (10 bar)
- (3) Foam production in accordance with Chapter 9 of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
- (4) On-station fuel capacity: 6 hours
- (5) Minimum number of monitors: 2
- (6) Minimum number of discharge outlets: 2 [$\geq 3\frac{1}{2}$ in. (89 mm)]

5.2.5 Marine fire-fighting vessels and special purpose fire-fighting vessels designated as Type V shall meet the following minimum requirements:

- (1) Minimum number of pumps: 1
- (2) Minimum pumping capacity: 500 gpm (2000 L/min) @ 150 psi (10 bar)
- (3) On-station fuel capacity: 4 hours
- (4) Minimum number of monitors: 1

Chapter 6 Fire-Fighting System Capabilities

6.1 General.

6.1.1 The selection of pumps and design of distribution piping shall be done in consideration of the Determination of Needs Study per 4.2.2 and the following:

- (1) Number, sizes, and types of distribution devices expected to be used singularly or simultaneously
- (2) Pressure required at the inlets of the discharge devices
- (3) Required full-range fire flow

6.1.1.1 Where the fire pumps and distribution piping are used to supply thrusters for station keeping, the fire pump capacity and distribution pipe size shall be increased to permit station keeping without decreasing fire flow capacity.

6.1.1.2 Where the distribution piping from the fire pumps also supplies the vessel protection systems, the demand for those vessel protection systems shall be added to the fire pump distribution piping to permit simultaneous use without decreasing the fire flow capability.

6.2 System Design.

6.2.1* Fire-fighting piping systems shall be designed for not less than the maximum potential flow rate, cut-off pressure of the pump(s), or relief valve setting of the pump.

6.2.2 The pump suction velocity shall generally not exceed 6.5 ft/sec (2 m/sec), and discharge piping shall generally not exceed 13 ft/sec (4 m/sec) at the design flow rate for each section of pipe.

6.2.3 Recommended flow rates shall be permitted to be exceeded where other aspects of the design could be compromised by fitting larger or heavier pipes and fittings, provided the impact of the higher rates on erosion in piping and fittings is identified and accepted by the owner/operator, and the higher flow resistance does not impair the performance of the system.

6.2.4 Where a common suction or discharge header is connected to more than one pump, the design flow rate in the header shall reflect the combined capacity of all connected pumps operating simultaneously.

6.2.5 Means shall be provided to prevent the pump from overheating with distribution devices closed, such as an overboard discharge.

6.2.6 Where multiple pumps are installed, the failure of any single pump shall not reduce fire flow by more than 50 percent.

6.2.7 Where piping serves multiple pumps, the failure of any piping shall not reduce fire flow by more than 50 percent.

6.2.8 Pump discharge piping shall include a check valve and isolation valve for each pump in a multiple pump system.

6.2.9 Isolation valves shall be installed where necessary for each device or outlet and where necessary for continued operation of the system in case of piping or component failure.

6.2.10 A shutoff valve shall be provided in the supply to each monitor.

6.2.11 Suction Arrangement.

6.2.11.1* The suction arrangements for each pump shall include at least one dedicated sea chest with screened inlet, a valve at the sea chest outlet, and a valved vent to atmosphere.

6.2.11.2 Where pump suction are arranged in a manifold (sea main), an isolation valve shall be provided at or near the suction inlet of each pump.

6.2.11.3* The open area of the screen shall be at least two times the cross-sectional area of the suction pipe, and the individual openings shall not be larger than the pump manufacturer's maximum particle size.

6.2.11.4 The intakes to all fire pumps shall be fitted with a means of clearing while the vessel is afloat.

6.2.12 System Pressure Ratings and Control.

6.2.12.1 Fire-fighting pump discharge piping shall be designed for a working pressure not less than the maximum cut-off pressure of the pump(s) fitted, except as noted in 6.2.12.3 and 6.2.12.4.

6.2.12.2 Piping systems shall be designed to avoid water hammer and similar hydraulic shocks within the system during operation by fitting valve operators with controlled opening/closing rates in accordance with 6.3.6.3 and by providing the means to purge air from the piping system at low flow velocities.



6.2.12.3 The use of automatic pressure relief valves in systems shall be permitted where the piping system cannot satisfy 6.2.12.1.

6.2.12.4* Where pressure relief valves are fitted, the discharge(s) shall be to the pump suction or, if discharged outside the marine fire-fighting vessel, the discharge shall be above the waterline and in a position least likely to affect vessel operations or the safety of other vessels or personnel in the vicinity.

6.2.13 Drains.

6.2.13.1 Drains shall be provided to drain all portions of the discharge and distribution piping.

6.2.13.2 A small valved drain line that bypasses each pump check valve shall be provided to permit drainage of the discharge piping.

6.2.14 Flushing. All vessels operating in salt or brackish water shall have a means of flushing the distribution system with fresh water.

6.3 Components and Materials.

6.3.1 General.

6.3.1.1 All components shall have design pressure ratings equal to or greater than the maximum pump pressure or relief valve setting.

6.3.1.2 All piping, fittings, and valves shall be constructed of materials that resist galvanic corrosion.

6.3.1.3 Any components and materials to be used with fire-fighting foams shall be compatible with the type of foam concentrate to be used.

6.3.2 Piping.

6.3.2.1 Where steel pipe is joined by threaded fittings referenced in 6.3.3, the minimum wall thickness shall be in accordance with Schedule 40 for pressures up to 300 psi (20.7 bar).

6.3.2.2 Bending of pipe and tube shall be in accordance with *ABS Rules for Building and Classing Steel Vessels Under 90 Meters (295 ft) in Length*.

6.3.3 Fittings.

6.3.3.1 Threaded fittings shall not be used on pipe larger than 2 in. (50 mm).

6.3.3.2 A one-piece reducing fitting shall be used wherever a change is made in the size of the pipe.

6.3.3.3 All threaded pipe and fittings shall have threads cut according to ANSI/ASME B1.20.1, *Pipe Threads, General Purpose (Inch)*.

6.3.3.4 Hexagonal or face bushings shall be permitted in reducing the size of openings of fittings when standard fittings of the required size are not available.

6.3.4 Welded Pipe and Fittings. Welding to join pipes and fittings shall be permitted provided that the welding methods comply with AWS B2.1, *Specification for Welding Procedure and Performance Qualification*.

6.3.5 Brazed Joints.

6.3.5.1 Joints for the connection of copper tube shall be brazed or welded in accordance with Subchapter F of 46 CFR 56.70, "Welding."

6.3.5.2 Excess flux shall be removed after brazing.

6.3.6 Valves.

6.3.6.1 All valves used in the pump piping system shall be equipped with an operating mechanism that visually indicates the position of the valve at all operating locations.

6.3.6.2 All valves shall be arranged so that the open or closed position is clearly indicated directly on the valve.

6.3.6.3 Discharge valves shall be capable of being opened and closed smoothly and readily at flow velocities up to 20 ft/sec (6 m/sec).

6.3.6.3.1 The flow-regulating element of each discharge piping valve shall not change its position under any condition of operation involving discharge pressures to the maximum pressure of the pump.

6.3.6.3.2 The means to prevent a change in position shall be incorporated in the operating mechanism and shall be either manually or automatically controlled.

6.3.6.3.3 Each 3 in. (76 mm) or larger discharge piping valve shall have an operating mechanism that does not permit changing the position of the flow-regulating element of the valve from fully closed to fully open, or vice versa, in less than 3 seconds.

6.3.6.4 Suction valves shall be capable of being opened and closed smoothly and readily at flow velocities up to 15 ft/sec (4.6 m/sec).

6.3.6.5 Valves that are remotely controlled shall have a manual override feature located at the valve.

6.3.7* Pumps.

6.3.7.1 Pump materials shall be galvanically compatible and shall be suitable for the pump's rated capacity, pressure, speed, ambient water temperature, and corrosiveness.

6.3.7.2 Pumps shall be installed below the waterline where possible, and in all cases the net positive suction head (NPSH) shall be verified for the proposed installation and pump performance.

6.3.7.3 Pumps installed above the waterline shall be designed to operate at rated capacity with a total suction lift not to exceed 10 ft (3 m).

6.3.7.4 Net pump pressure at rated capacity shall be 150 psi (10.34 bar) or greater for all vessels.

6.3.7.5 The pump manufacturer shall hydrostatically test the pump at twice the rated discharge pressure of the pump.

6.3.7.6 Certification.

6.3.7.6.1 The pump manufacturer shall test each pump prior to shipping and shall certify that the pump meets the provisions of this standard.

6.3.7.6.2 The certification for each pump shall be provided to the owner.

6.3.8 Discharge Devices.

6.3.8.1* General.

6.3.8.1.1 All discharge devices shall be supported by the vessel structure to minimize stresses on piping and valves.

6.3.8.1.2 Discharge outlets and all fire hose connections shall have connections as specified in NFPA 1963, *Standard for Fire Hose Connections*.

6.3.8.2' Monitors.

6.3.8.2.1* For all marine fire-fighting vessels, a single monitor or combination of monitors shall provide an unobstructed range of horizontal operation of at least 270 degrees centered on the bow of the vessel and shall have a vertical coverage of at least 60 degrees above and 15 degrees below horizontal.

6.3.8.2.2 Means shall be provided to prevent damage to the vessel's structure or equipment from the operation of the monitors.

6.3.8.2.3 Monitor supports shall be designed for all operational loadings at maximum flows and pressures.

6.3.8.2.4 Controls for nozzle rotation, elevation, and discharge pattern shall be located not less than 3 ft (0.9 m) and not more than 6 ft (1.8 m) above the deck or platform that serves as the operator's station for that monitor.

6.3.8.2.5 Monitors equipped with remote controls shall be designed so that each can be operated manually.

6.3.8.2.6 Remote control stations for monitors shall have operational visibility substantially equal to the operational range of the monitor.

6.3.8.2.7 Each monitor operator position shall have an effective means of communication with the vessel's operator position.

6.3.8.2.8 Control systems for remote-controlled monitors shall be protected with overload or circuit breaker protection.

6.3.8.3 Discharge Outlets.

6.3.8.3.1 For Type III through Type V vessels, hose connections shall be provided to discharge 100 percent of the rated pump capacity. For Type I and Type II vessels, hose connections shall be determined with special consideration of the Determination of Needs Study, per 4.2.2.

6.3.8.3.2 On vessels where a fixed foam system is installed, a means of providing foam solution to one or more hose outlets shall be provided.

6.3.9 Installation.

6.3.9.1 All components and equipment shall be installed in accordance with manufacturers' requirements.

6.3.9.2 Piping shall be supported from the vessel structure to carry the load of a completely filled piping system, allowing for the anticipated vertical design accelerations, which can reasonably be expected in the service.

6.3.9.3 Where flanges are used to join piping or to facilitate removal of valves for service, a support shall be provided not more than 2 ft (0.6 m) from the joint.

6.3.9.4 Bracing shall be provided to resist the nozzle reaction of discharge devices.

6.3.9.5 Provision shall be made for the expansion or contraction of piping and for stresses in the piping due to temperature changes or flexing of the hull.

6.3.10 Controls, Indicators, and Instruments.

6.3.10.1 When mechanical indicators are used, all master fire pump pressure indicators shall have a dial not less than 3½ in. (90 mm) in diameter.

6.3.10.1.1 When mechanical indicators are used, indicator connections shall be accessible to permit back flushing of pressure tubing from remote indicator locations.

6.3.10.2 The suction indicator indicator, when provided, shall be a compound type ranging from 30 in. Hg (760 mm Hg) to 15 psi (1 bar).

6.3.10.2.1 Suction indicators shall not be required on Type V vessels.

6.3.10.3 The discharge pressure indicator range shall be from 0 psi (0 bar) to twice the maximum pressure that the pump produces.

6.3.10.4 A pump pressure indicator shall be provided to monitor fire main pressure and shall be visible to the fire system operator.

6.3.11 Testing.

6.3.11.1 The installed discharge piping shall be hydrostatically tested for not less than 1 hour at not less than 200 psi (13.8 bar), or at 50 percent greater pressure than the rated cut-off pressure of the pump(s), whichever is greater.

6.3.11.2 Pressure test instrument connections shall be provided at each pump and monitor.

6.3.11.3 The pressure test instrument connections at each pump shall include a connection for original and periodic testing of the pump's performance.

6.3.11.4 A valved test connection shall be located for accessibility above deck plates as close to the gauge tap on the pump flange as possible.

Chapter 7 Foam Systems

7.1 General.

7.1.1 Where the marine fire-fighting vessel is equipped with a fixed or portable foam system, the requirements of this chapter and NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, shall apply.

7.1.2* The selection of the foam-proportioning system shall be made only after a complete review of the foam performance necessary to satisfy the requirements of the mission and capability study.

7.1.3 The purchaser shall provide the following minimum performance requirements for the installed system:

- (1) Minimum and maximum foam solution flow rates
- (2) Foam solution proportioning rate or range
- (3) Minimum operating time required
- (4) Minimum performance requirements of system discharge devices including at least flow, pressure, reach, whether aspirated or nonaspirated

7.2 Design and Performance Requirements.

7.2.1 The vessel shall be capable of supplying the power required by the foam-proportioning system in addition to the requirements of the other power-dependent systems installed on the vessel.

7.2.2 The foam-proportioning system shall be designed to operate with the type(s) of foam concentrate specified by the purchaser.



7.2.3* The materials and system components used in the construction of the foam concentrate storage and proportioning and delivery system shall be compatible with the concentrate as specified by the foam manufacturer.

7.2.4 For Type I through Type III vessels, the foam-proportioning system shall be an integral part of the water delivery system.

7.2.4.1 Type IV and Type V marine fire-fighting vessels shall be permitted to utilize portable foam delivery systems in accordance with Chapter 9 of NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*.

7.2.5 The vessel builder shall demonstrate the following:

- (1) Maximum rate of foam solution delivery capable of being discharged from the system at a given rate of proportioning
- (2) Maximum operating pressure of the foam-proportioning system
- (3) Minimum and maximum rate of foam solution discharge available at each individual outlet equipped with a foam-proportioning device

7.2.6 Discharge or pressure lines in the foam-proportioning system shall be designed and installed so that the velocity of the foam concentrate in the lines does not exceed 25 ft/sec (8 m/sec) at the maximum design flow.

7.2.7 Suction lines in the foam-proportioning system shall be designed and installed so that the velocity of the foam concentrate in the lines does not exceed 15 ft/sec (4.6 m/sec) at the maximum design flow.

7.2.8 The operating characteristics of the selected individual foam system components shall be reviewed to ensure that the installed system meets or exceeds the design performance requirements.

7.2.9 Components that can be flushed with water after use shall be constructed of materials that are resistant to corrosion after being flushed with fresh water and allowed to dry.

7.2.9.1 The components in 7.2.9, including, but not limited to, gaskets, seals, and binding of moving parts, shall also be constructed of materials resistant to deterioration by foam concentrates.

7.2.10 Where eductors are used, their flow rating shall be matched with the flow rating of the delivery devices they serve.

7.2.11 A check valve or similar means of isolation shall be installed in the concentrate delivery piping as close to the proportioners as possible to prevent the mixing/contamination of the concentrate with backflow of fire main water.

7.3 Controls.

7.3.1 All foam-proportioning system controls shall be clearly identified and readily accessible.

7.3.2 Foam-proportioning systems that incorporate a foam concentrate pump and tank shall include provisions to allow resupply while the system is in operation.

7.3.3 Foam-proportioning systems that require flushing after use shall include readily accessible controls that allow the system to be flushed completely with fresh water according to the manufacturer's instructions.

7.3.4 Foam systems that incorporate automatic proportioning features shall be equipped with controls that allow the automatic feature to be bypassed for manual operation.

7.3.5 For foam-proportioning systems that incorporate foam concentrate metering valves, each metering valve shall be calibrated and marked to indicate the range of foam concentrate proportioning rate(s) available as determined by the design of the system.

7.4 Gauges, Flowmeters, and Indicators.

7.4.1 All gauges, flowmeters, and indicators shall be located so they are readily visible.

7.4.2 All gauges or flowmeters shall be mounted in a manner to protect the gauge from physical damage and from excessive vibration.

7.4.3 Foam concentrate tanks with a capacity of 500 gal (2000 L) or more shall be provided with a gauging device for determining remaining foam concentrate volume in the tank.

7.5 Nameplates and Instruction Plates.

7.5.1 All labels and marking shall be of a type permanent in nature, shall be capable of withstanding the effects of extreme weather and temperature, and shall be attached in a manner that requires mechanical means to remove.

7.5.2 A nameplate shall be provided for each control, gauge, and indicator that is clearly marked with the identification and function of that device.

7.5.3 An instruction plate shall be provided for the foam-proportioning system that includes, as a minimum, a piping schematic of the system and basic operation instructions.

7.5.3.1 Foam concentrate trade names shall not be substituted for foam solution percentage ratios on instruction plates.

7.5.4 A label that reads "Foam Tank Fill" shall be provided at any foam tank fill opening and shall indicate the type and proportioning percentage of concentrate required.

7.6 Atmospheric Foam Concentrate Tank.

7.6.1 Where the vessel's foam-proportioning system incorporates an atmospheric foam concentrate tank, the requirements of this section shall apply.

7.6.2 The foam concentrate tank and associated piping shall be constructed of materials in accordance with 7.2.3.

7.6.3 The foam concentrate tank shall be provided with a protected fill opening that is designed to facilitate the operator's filling the tank from 5 gal (20 L) foam concentrate containers.

7.6.3.1 Foam concentrate tanks larger than 200 gal (800 L) shall incorporate a fill opening with an area of at least 36 in.² (2320 mm²).

7.6.3.2 Where a fill opening is less than 36 in.² (2320 mm²), a fill funnel with strainer shall be provided with a neck to fit the fill opening and a minimum 36 in.² (2320 mm²) fill cup.

7.6.3.3 Foam concentrate tanks of 200 gal (800 L) or less shall incorporate a fill opening with an area not less than 4 in.² (260 mm²).

7.6.4 The tank opening shall be protected by a removable cover and screen.